

# Public Update for Drought Response

Groundwater Basins with Potential Water Shortages, Gaps in Groundwater Monitoring, Monitoring of Land Subsidence, and Agricultural Land Fallowing

Prepared pursuant to April 2014 Proclamation of a Continued State of Emergency

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State of California | Natural Resources Agency | California Department of Water Resources

**On the cover:** Rainfed oat field in Yolo County, California, winter 2013.

Photo by Rachael Freeman Long, Farm Advisor for Field Crops and Pest Management at the University of California  
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During 2014, most of California experienced extreme drought conditions and one of the driest and warmest years on record.

Many areas continue to be challenged by drought conditions and are experiencing critical water shortages. Persisting water supply challenges have required a high level of collaboration among local, state, federal, and non-governmental agencies, and the public. Drought response activities have highlighted the importance of multi-agency coordination and communication, streamlined processes, and resolving challenges in a timely manner.

As directed by the Governor's April 2014 Proclamation of a State of Emergency, this report is an update on the continued efforts of many local, State, and federal agencies to collect, analyze, and disseminate the latest groundwater conditions. The report identifies groundwater level changes, groundwater basins with potential water shortages, gaps in groundwater level monitoring, land subsidence, and fallowing of agricultural lands. The findings of this report reflect work of these agencies and supports the need for sustainable management for all of California's water resources.

Despite the drought, this year has been a success for California water management. The year has included Executive Orders to address water transfers and drought conditions, the release of the California Water

Action Plan, the passage of historic groundwater management legislation, and voter approval of Proposition 1, a \$7.5 billion general obligation water bond. Now, more than ever, California is poised to address its water supply challenges.

The Department of Water Resources and its partner agencies are taking steps to align their groundwater programs to the California Water Action Plan and the new groundwater legislation. This effort will complement and support the goal of sustainable groundwater management by providing data, technical, and financial support to local management agencies. The Department is committed to implementing the new legislation in close coordination and collaboration with local agencies, the State Water Resources Control Board, and other stakeholders.

Extreme drought conditions have highlighted the need to address and manage the state's water resources for all beneficial uses. The time is right to take the necessary actions to achieve long-term sustainability of our water resources, especially the vital groundwater which we rely upon so heavily in times of drought.

A handwritten signature in black ink, appearing to read 'Bill Croyle', written in a cursive style.

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**Acronyms**

CalOES .....	California Office of Emergency Services
CASGEM .....	California Statewide Groundwater Elevation Monitoring
CSU .....	California State University
DWR .....	Department of Water Resources
GIS .....	Geographic Information System
GPS .....	Global Positioning System
InSAR .....	Interferometric Synthetic Aperture Radar
NASA .....	National Aeronautics and Space Administration
NASS .....	National Agricultural Statistics Service
OSWCR .....	Online System for Well Completion Reports
SWRCB .....	State Water Resources Control Board
UCD .....	University of California, Davis
USDA .....	U.S. Department of Agriculture
USGS .....	U.S. Geological Survey
WCR .....	Well Completion Report
WDL .....	Water Data Library



# Executive Summary

California's Water Year 2014 (October 1, 2013 through September 30, 2014) was one of the driest in decades and followed two consecutive dry years throughout the state. Water year 2014 was the fourth driest year on record after 1924, 1931, and 1977, based on the Sacramento Valley water year index, and the second driest year on record after 1977, based on the San Joaquin Valley water year index. On January 17, 2014, Governor Brown signed a Proclamation of a State of Emergency in response to the drought. In accordance with the proclamation, the Department of Water Resources (DWR) prepared *Public Update for Drought Response, Groundwater Basins with Potential Water Shortages and Gaps in Groundwater Monitoring*, dated April 30, 2014. On April 25, 2014, the governor issued a second emergency proclamation to strengthen the state's ability to manage water and habitat effectively in drought conditions and called on all Californians to redouble their efforts to conserve water. In accordance with Order #11 of the April proclamation, this report provides additional and expanded information on groundwater basins with potential water shortages, gaps in groundwater monitoring, monitoring of land subsidence, and agricultural land fallowing.

**G**roundwater is a vital resource in California, providing close to 40 percent of the state's water supply in an average year. In some regions of the state, groundwater accounts for as much as 60 percent of the supply during dry or drought years. Drought conditions typically result in an increase of groundwater well activity and pumping to compensate for surface water supply shortages. Increased groundwater pumping can lead to adverse conditions including dry wells, land subsidence, water quality impacts, seawater intrusion, and stream depletion. Drought conditions can also cause significant

economic impacts to major water-dependent industries such as agriculture. Fallowing agricultural lands is one indicator of drought impacts.

The report presents the following key findings:

## **Groundwater basins with potential water shortages**

- » Based on well completion reports received this year through September 2014, more than 350 new water supply wells are reported in Fresno and Tulare counties, and more than 200 water supply wells are reported in Merced County. More than 100 new water supply

wells are reported in Butte, Kern, Kings, Shasta, and Stanislaus counties.

- » Groundwater levels have decreased in many basins throughout the state since spring 2013, and more notably since spring 2010. Basins with notable decreases in groundwater levels are in the Sacramento River, San Joaquin River, Tulare Lake, San Francisco Bay, Central Coast, and South Coast hydrologic regions.
- » Based on the available fall 2014 data, groundwater levels have decreased in many basins throughout the state since fall 2013.
- » Based on the available data, there are many High and Medium Priority basins that experienced spring 2014 groundwater levels which rank in the lowest 10th percentile of measurements.

**Gaps in Groundwater Monitoring**

- » As of October 7, 2014, 34 of the 127 High and Medium priority basins and subbasins are either partially or fully unmonitored under the California Statewide Groundwater Elevation Monitoring (CASGEM) Program.
- » For the High and Medium priority basins, there are significant gaps in groundwater monitoring for the San Joaquin River, Tulare Lake, and Central Coast hydrologic regions.

**Land subsidence**

- » Subsidence is occurring in many groundwater basins in the state, especially in the southern San Joaquin River and Tulare Lake hydrologic regions.
- » Due to ongoing decline of groundwater levels, areas with a higher potential for future subsidence are in the southern San Joaquin, Antelope, Coachella, and western Sacramento valleys.

**Agricultural land fallowing**

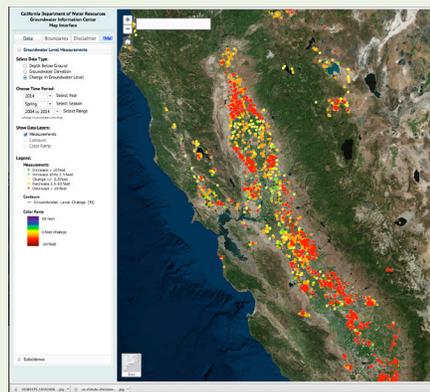
- » A multi-agency research project led by NASA estimated that peak summer acreage of Central Valley land idled (due to drought impacts, normal agronomic practices, crop markets, etc.) in 2014 was 1.7 million acres, almost 700,000 acres more than in 2011, a recent wet year.

Information regarding current drought conditions and DWR’s drought response efforts is available at [www.water.ca.gov/waterconditions](http://www.water.ca.gov/waterconditions). For the latest groundwater level data and detailed information regarding groundwater and groundwater management in California, please visit DWR’s Groundwater Information Center at [www.water.ca.gov/groundwater](http://www.water.ca.gov/groundwater).



**Groundwater Information Center**

The Groundwater Information Center is DWR’s portal for groundwater information, groundwater management plans, water well basics, and statewide and regional reports, maps and figures.



**Interactive map**

The interactive map is a web-based application which allows for the sharing of much of the data, reports, and other information provided in the Groundwater Information Center.

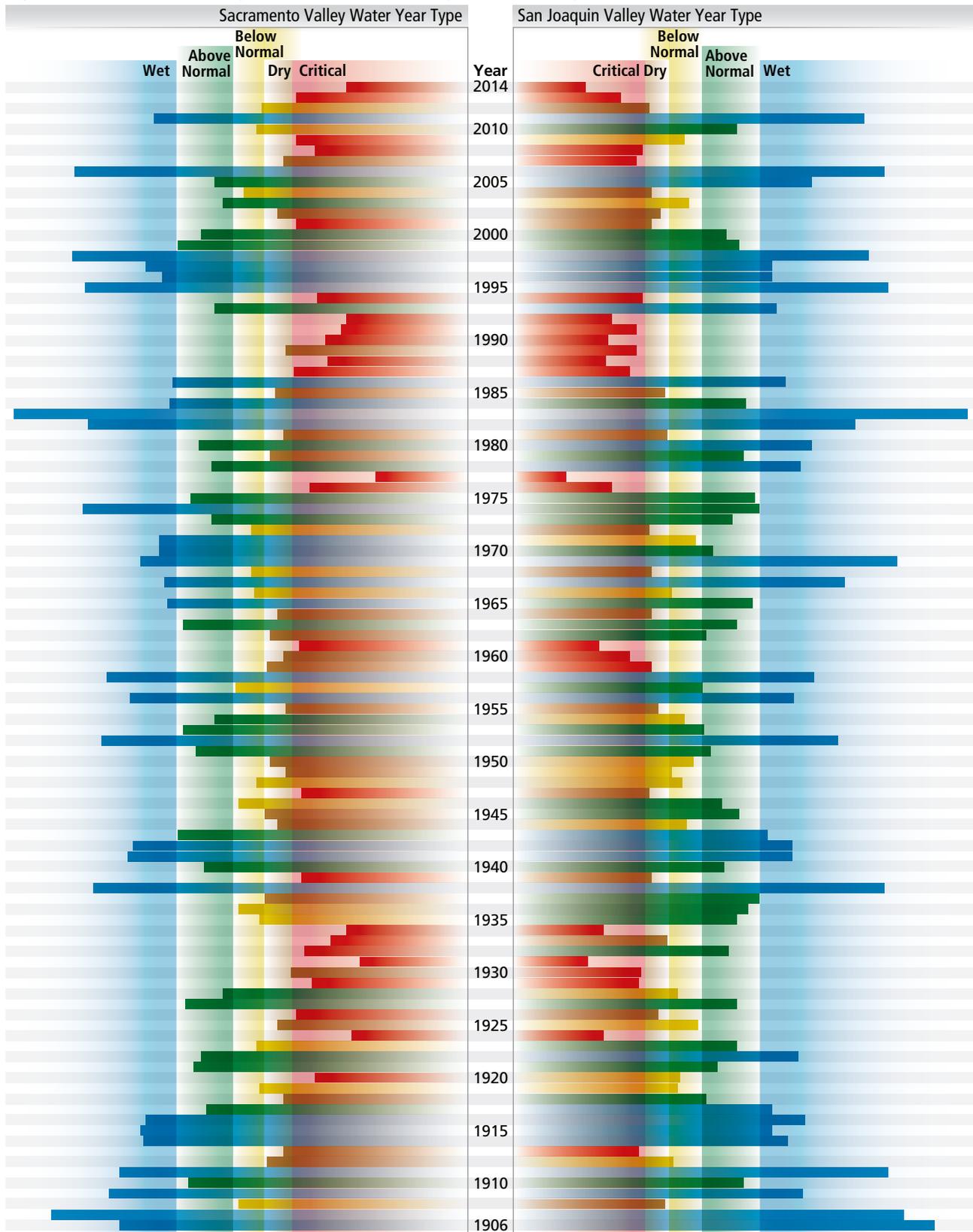
# Introduction

California's Water Year 2014 (October 1, 2013 through September 30, 2014) was one of the driest in decades and follows two consecutive dry years throughout the state. Water year 2014 was the fourth driest year on record after 1924, 1931, and 1977, based on the Sacramento Valley water year index, and the second driest year on record after 1977, based on the San Joaquin Valley water year index (Figure 1). On January 17, 2014, Governor Brown signed a Proclamation of a State of Emergency ([www.gov.ca.gov/news.php?id=18368](http://www.gov.ca.gov/news.php?id=18368)) in response to the drought. Pursuant to the proclamation, DWR completed *Public Update for Drought Response, Groundwater Basins with Potential Water Shortages and Gaps in Groundwater Monitoring* dated April 30, 2014 ([www.water.ca.gov/waterconditions](http://www.water.ca.gov/waterconditions)).

On April 25, 2014, the governor issued a second proclamation ([www.gov.ca.gov/news.php?id=18496](http://www.gov.ca.gov/news.php?id=18496)) to strengthen the state's ability to manage water and habitat effectively in drought conditions and called on all Californians to redouble their efforts to conserve water. This report addresses Order #11 of the April 2014 proclamation: *The Department of Water Resources will conduct intensive outreach and provide technical assistance to local agencies in order to increase*

*groundwater monitoring in areas where the drought has significant impacts, and develop updated contour maps where new data becomes available in order to more accurately capture changing groundwater levels. The Department will provide a public update by November 30 that identifies groundwater basins with water shortages, details remaining gaps in groundwater monitoring, and updates its monitoring of land subsidence and agricultural land following.*

Figure 1: Sacramento Valley and San Joaquin Valley Water Year Types – 1906 to 2014



## 2

# Purpose and Scope

To identify groundwater basins with potential water shortages and gaps in groundwater monitoring, DWR analyzed available data from the Water Data Library (WDL) groundwater level database, the California Statewide Groundwater Elevation Monitoring (CASGEM) Program, and from well completion reports (WCRs, also known as driller's logs). Groundwater level analysis and maps completed for spring 2014 included groundwater level data available as of November 1, 2014. Although spring 2014 data were presented in the April 2014 Public Update, some data were absent because they were not available at the time of the April report. Therefore, this report includes an updated analysis using a complete set of spring 2014 data. DWR utilized fall 2014 groundwater level data available as of November 1, 2014. Some fall 2014 data are likely unavailable to include in this report because fall groundwater level measurements are typically collected in September and October, and may not have been uploaded to the WDL database by November 1. DWR utilized well completion reports available as of October 1, 2014, and utilized CASGEM Program data as of October 7, 2014.



## 3

# Analysis and Findings

Drought conditions continue to stress California's people, environment, and economy. Available surface water supplies are limited and drought conditions have resulted in an increased use of groundwater to meet demand. DWR analyzed new well activity and available groundwater level data to ascertain basins with potential water shortages, and evaluated available groundwater level monitoring networks to identify gaps in monitoring. DWR also analyzed available land subsidence and agricultural land fallowing data to identify areas impacted by drought conditions.

**T**he report presents the following key findings:

### **Groundwater basins with potential water shortages**

Based on well completion reports received this year through September 2014, more than 350 new water supply wells are reported in Fresno and Tulare counties, and more than 200 water supply wells are reported in Merced County. More than 100 new water supply wells are reported in Butte, Kern, Kings, Shasta, and Stanislaus counties. Groundwater levels have decreased in many basins throughout the state since spring 2013, and more notably since spring 2010. Basins with notable decreases in groundwater levels are in the Sacramento River, San Joaquin River, Tulare Lake, San Francisco Bay, Central Coast, and South Coast hydrologic regions. Based on the available fall 2014 data, groundwater levels have decreased in many basins throughout the state since fall 2013. Based on the available data, there are many High

and Medium Priority basins that experienced spring 2014 groundwater levels which rank in the lowest 10th percentile of measurements.

### **Gaps in groundwater monitoring**

As of October 7, 2014, 34 of the 127 High and Medium priority basins and subbasins are either partially or fully unmonitored under the California Statewide Groundwater Elevation Monitoring (CASGEM) Program. For the High and Medium priority basins, there are significant gaps in groundwater monitoring for the San Joaquin River, Tulare Lake, and Central Coast hydrologic regions.

### **Land subsidence**

Subsidence is occurring in many groundwater basins in the state, especially in the southern San Joaquin River and Tulare Lake hydrologic regions. Due to ongoing decline of groundwater levels, areas with a higher potential for future subsidence are in the southern San Joaquin, Antelope, Coachella, and western Sacramento valleys.

### **Agricultural land fallowing**

A multi-agency research project led by NASA estimated that peak summer acreage of Central Valley land idled (due to drought impacts, normal agronomic practices, crop markets, etc.) in 2014 was 1.7 million acres, almost 700,000 acres more than in 2011, a recent wet year.

Information regarding current drought conditions and DWR's drought response efforts is available at [www.water.ca.gov/waterconditions](http://www.water.ca.gov/waterconditions). For the latest groundwater level data and detailed information regarding groundwater and groundwater management in California, please visit DWR's Groundwater Information Center at [www.water.ca.gov/groundwater](http://www.water.ca.gov/groundwater).

## 4

# Groundwater Basins with Potential Water Shortages

In California, most groundwater is found in basins with alluvial deposits. Alluvial deposits are sediments deposited by rivers, or other water bodies, onto river beds, flood plains, and alluvial fans. Figure 2 depicts 515 alluvial groundwater basins as defined in DWR's Bulletin 118 Update 2003 (Bulletin 118-03, [water.ca.gov/groundwater/bulletin118/update\\_2003.cfm](http://water.ca.gov/groundwater/bulletin118/update_2003.cfm)). Close to 96 percent of the groundwater used in California is extracted from 127 of the 515 alluvial groundwater basins. According to the California Water Plan Update 2013 ([www.waterplan.water.ca.gov/cwpu2013](http://www.waterplan.water.ca.gov/cwpu2013)), total groundwater use was nearly 16.5 million acre feet and accounted for about 39 percent of the total water supply in California (based on average annual data for years 2005 to 2010). Groundwater is also found within fractured bedrock in foothill and mountainous areas. Although groundwater use from fractured bedrock settings is relatively small compared with the amount extracted from alluvial basins, the water supply is an important source for many individual domestic wells and small public water systems.

There are several options for evaluating the condition and status of a groundwater basin and whether there may be a shortage of groundwater supply relative to demand. For purposes of this report, newly completed water supply wells and changing groundwater levels were evaluated and used as indicators of potential water shortages in basins.

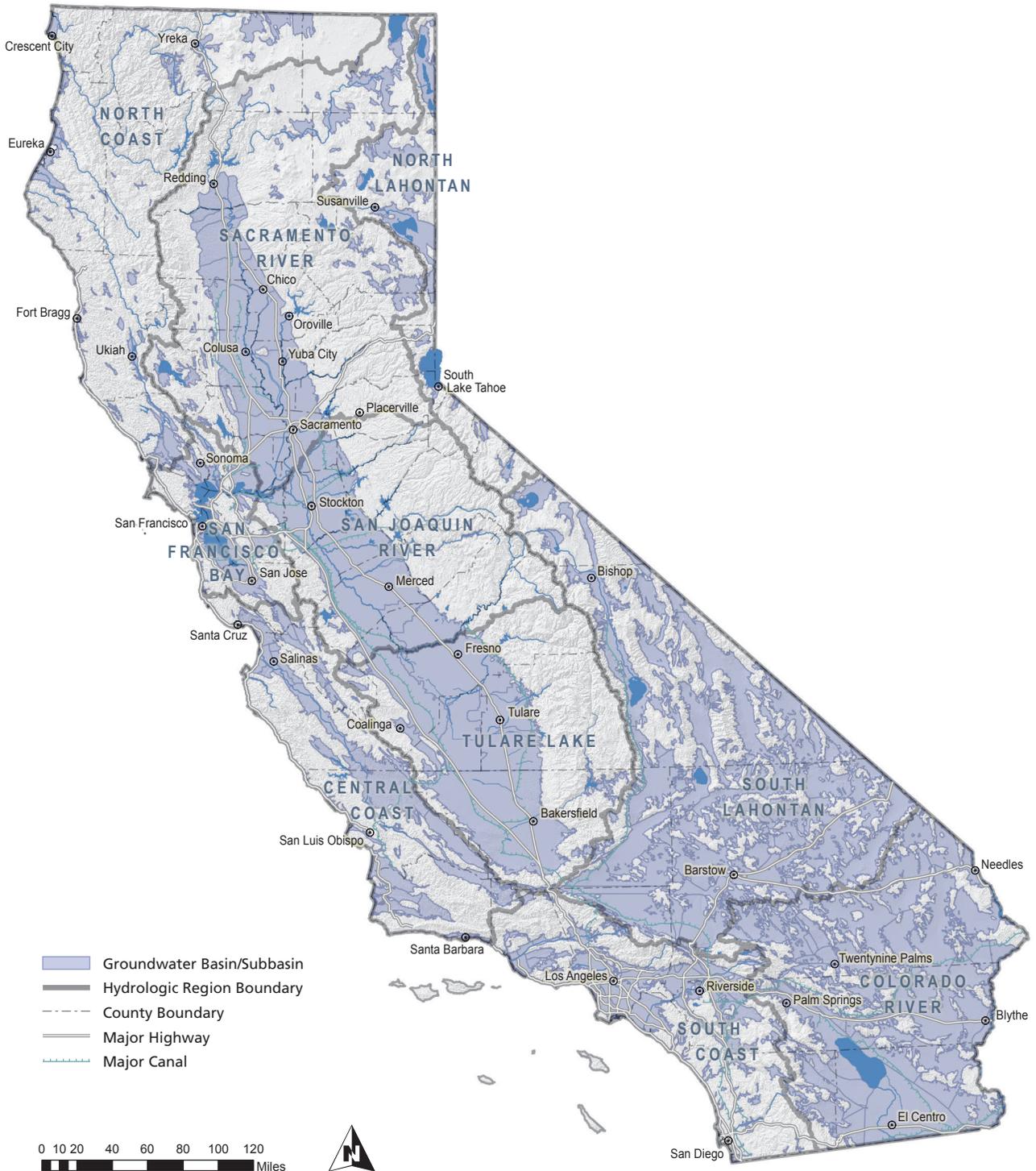
#### 4.1 NEW WATER SUPPLY WELLS

The number of new water supply wells completed in California varies each year. This variation is likely related to (1) hydrologic conditions, such as the

amount of precipitation received and the amount of surface water available, and (2) economic conditions, which affect new home construction and industrial and agricultural development. To better understand the impacts of the current drought and to help identify basins or areas with possible water shortages, new water supply wells completed during 1990 through summer of 2014 were evaluated.

Water well drillers are required to file a WCR with DWR within 60 days of the completion of a new water supply well (Water Code Section 13751). The WCRs can be analyzed to help understand patterns of well drilling

Figure 2: Bulletin 118-03 Alluvial Groundwater Basins



Map based on groundwater basin boundaries established in Bulletin 118 Update 2003, Department of Water Resources

activities and groundwater use. However, there are limitations with relying solely on the WCRs to characterize drilling activities. Analysis using WCRs could be incomplete because (1) well drillers have 60 days to file a WCR with DWR, (2) many WCRs are received much later than 60 days after completion of a new well, and (3) some WCRs are never submitted to DWR. A study conducted by DWR suggests that well drillers typically submit WCRs in excess of 90 days after work completion with maximum days to submit WCRs near 300 days.

For this report, available WCRs were used to evaluate the number of new water supply wells completed each year from 1990 through September 2014. Although most WCRs specify well locations to township, range, and section, the existing statewide database of WCRs allows for direct analysis by county. Thus, the analysis in this report only includes the well activity and planned uses by county and by year. DWR used available WCRs as of October 1, 2014. The analysis did not determine whether the new water supply wells are completed in alluvial groundwater basins or in fractured bedrock.

Figure 3 shows the numbers of new water supply wells reported in California each year from 1990 through September 2014. Figure 3 also shows the proportion of domestic wells, irrigation wells, public supply wells, and other water supply wells completed each year. The last group of wells (other) includes water supply wells used for industrial, livestock watering, unspecified agricultural, and unspecified water supply uses. The number of new wells reported per year ranges from almost 14,000 in 1990 to about 3,000 in 2011. Domestic supply wells are commonly a large proportion of new wells reported.

Figure 4 shows the California counties and the number of water supply wells that have been reported

## OSWCR

The new Online System for Well Completion Reports, (OSWCR, pronounced “Oscar”) will allow drillers to submit their reports online and will result in gathering timely, complete, and consistent well data. OSWCR is scheduled to be available in summer 2015. For more information, or to sign up for email news, please visit [www.water.ca.gov/oswcr](http://www.water.ca.gov/oswcr).



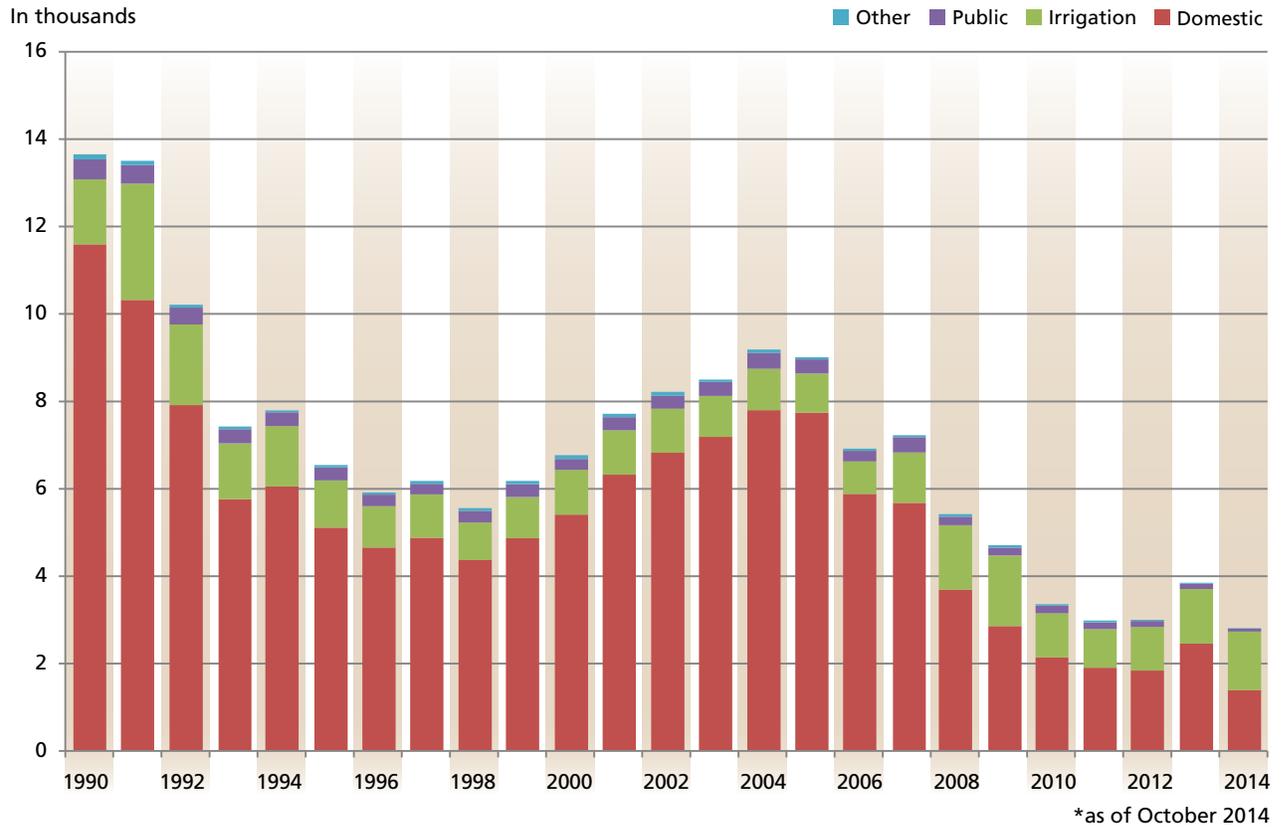
for 2014 (as of October 2014). More than 350 new water supply wells have been reported in Fresno and Tulare counties. More than 200 new water supply wells are reported in Merced County. More than 100 new water supply wells are reported in Butte, Kern, Kings, Shasta, and Stanislaus counties. These eight counties account for almost 57 percent of the new water wells reported for 2014 (as of October 2014). Fewer than 100 new water supply wells have been reported in each of the other 50 counties. About 50 percent of the new water supply wells reported for 2014 are for domestic use, 47 percent are for irrigation, three percent are for public water supply, and less than one percent are for other water supply uses.

## 4.2 GROUNDWATER LEVELS

The collection and evaluation of both seasonal and long-term groundwater level data are critical to assess the conditions of an alluvial groundwater basin and to best understand the aquifer system’s response to demand and recharge. Declining water levels may indicate that groundwater extraction is outpacing the aquifer recharge for the basin. However, some basins may be conjunctively managed to extract groundwater greater than recharge amounts in dry years, resulting in



Figure 3: Reported New Water Supply Wells 1990 to 2014\*



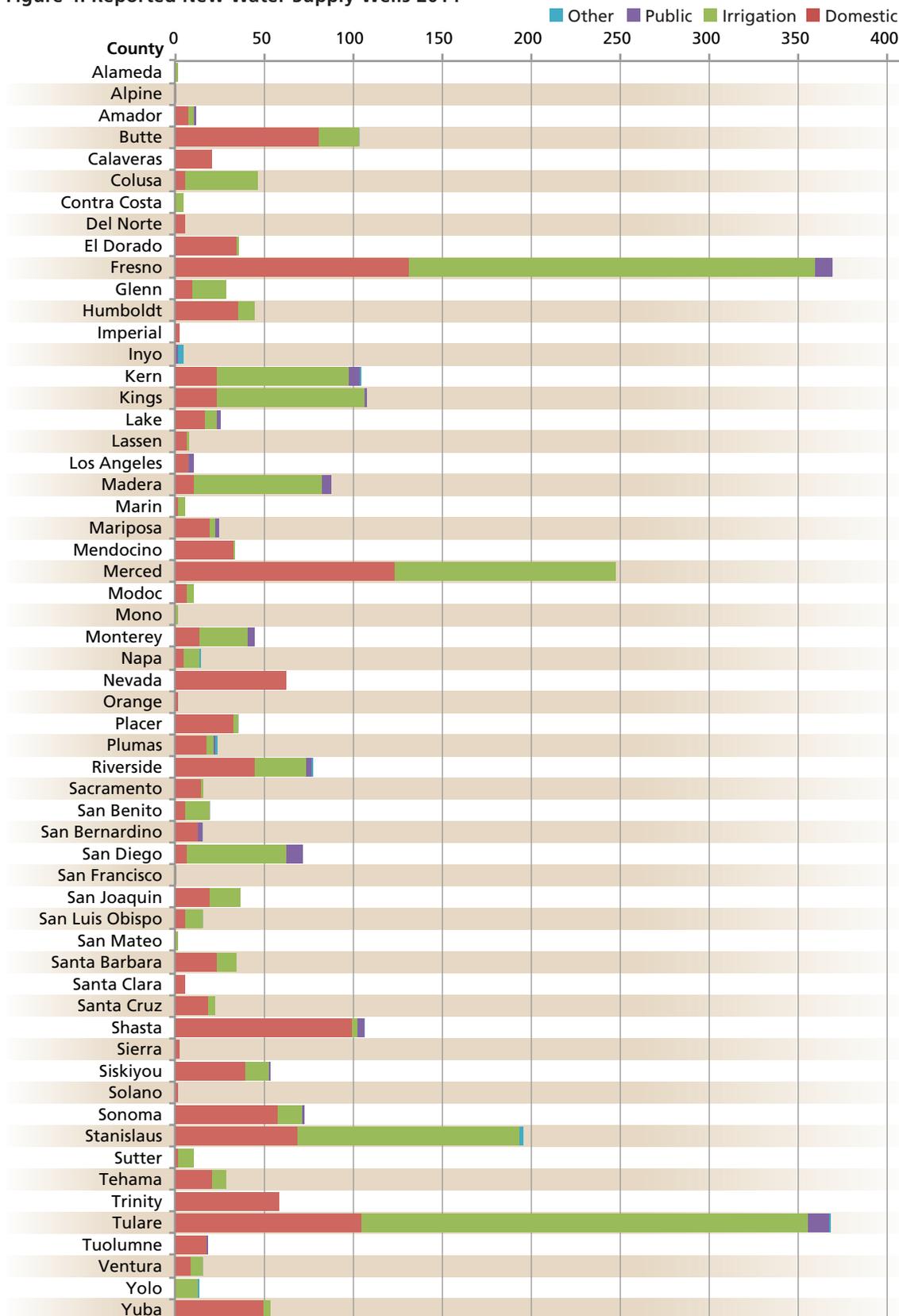
the lowering of water levels with subsequent recharge and recovery during wet years. In order to discern if a groundwater basin may be in shortage, seasonal and long-term groundwater levels must be analyzed over periods that include below normal and above normal water years.

The analysis presented in this report uses groundwater level measurements collected during the spring and fall. In most areas of California, spring measurements typically depict the highest groundwater elevations for the year, a time just prior to the irrigation season and after groundwater levels have had an opportunity to rebound from winter precipitation and early spring snowmelt. Fall measurements typically reflect groundwater conditions after the irrigation season when groundwater levels in many basins are expected to be at or near

their lowest levels for the year, and prior to recharge from winter precipitation and spring snowmelt.

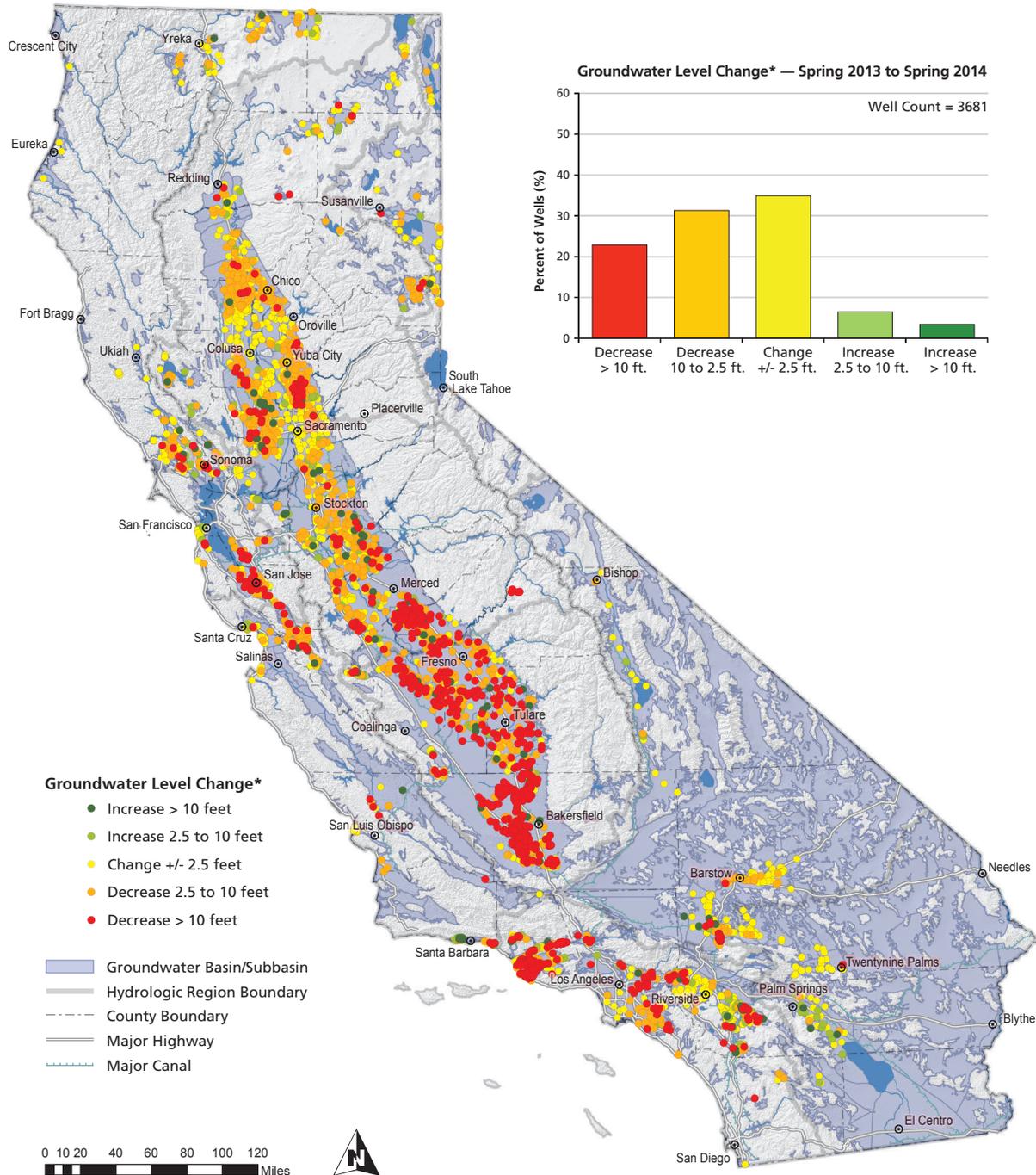
Groundwater level change maps depict the difference in groundwater levels at individual well locations over a specified time period. These maps provide a simple way to depict and evaluate local and regional changes and trends in groundwater levels. Figure 5 and Figure 6 depict change in groundwater levels at well locations from spring 2013 to spring 2014, and from spring 2010 to spring 2014, respectively. Based on the available data, groundwater levels have decreased in many basins throughout the state since spring 2013, and more notably since spring 2010. Basins with notable decreases in groundwater levels are in the Sacramento River, San Joaquin River, Tulare Lake, San Francisco Bay, Central Coast, and South Coast hydrologic regions.

Figure 4: Reported New Water Supply Wells 2014\*



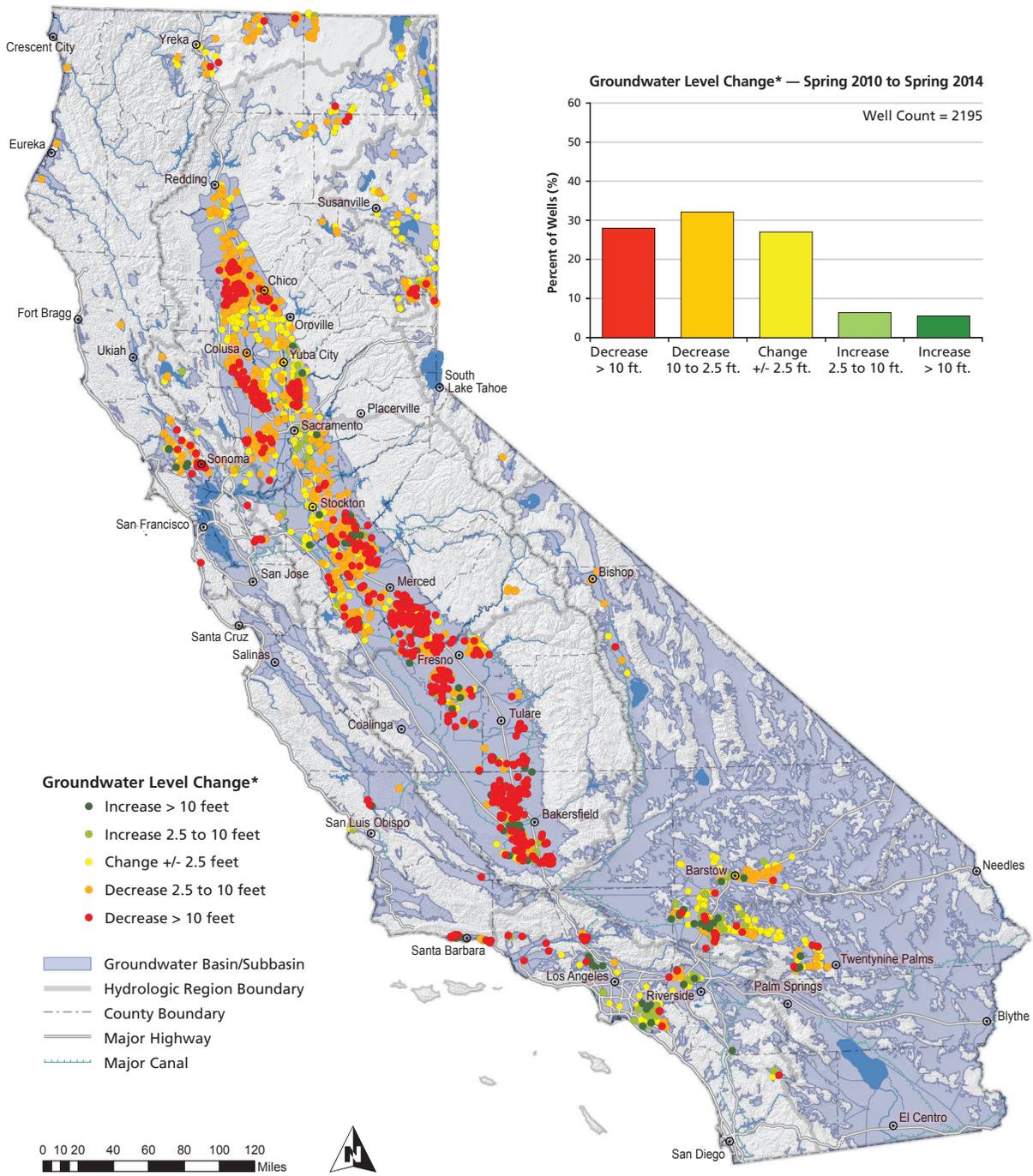
\*as of October 2014

Figure 5: Change in Groundwater Levels in Wells - Spring 2013 to Spring 2014



\*Groundwater level change determined from water level measurements in wells. Map and chart based on available data from the DWR Water Data Library as of 11/08/2014. Data subject to change without notice.

Figure 6: Change in Groundwater Levels in Wells - Spring 2010 to Spring 2014



\*Groundwater level change determined from water level measurements in wells. Map and chart based on available data from the DWR Water Data Library as of 11/08/2014. Data subject to change without notice.

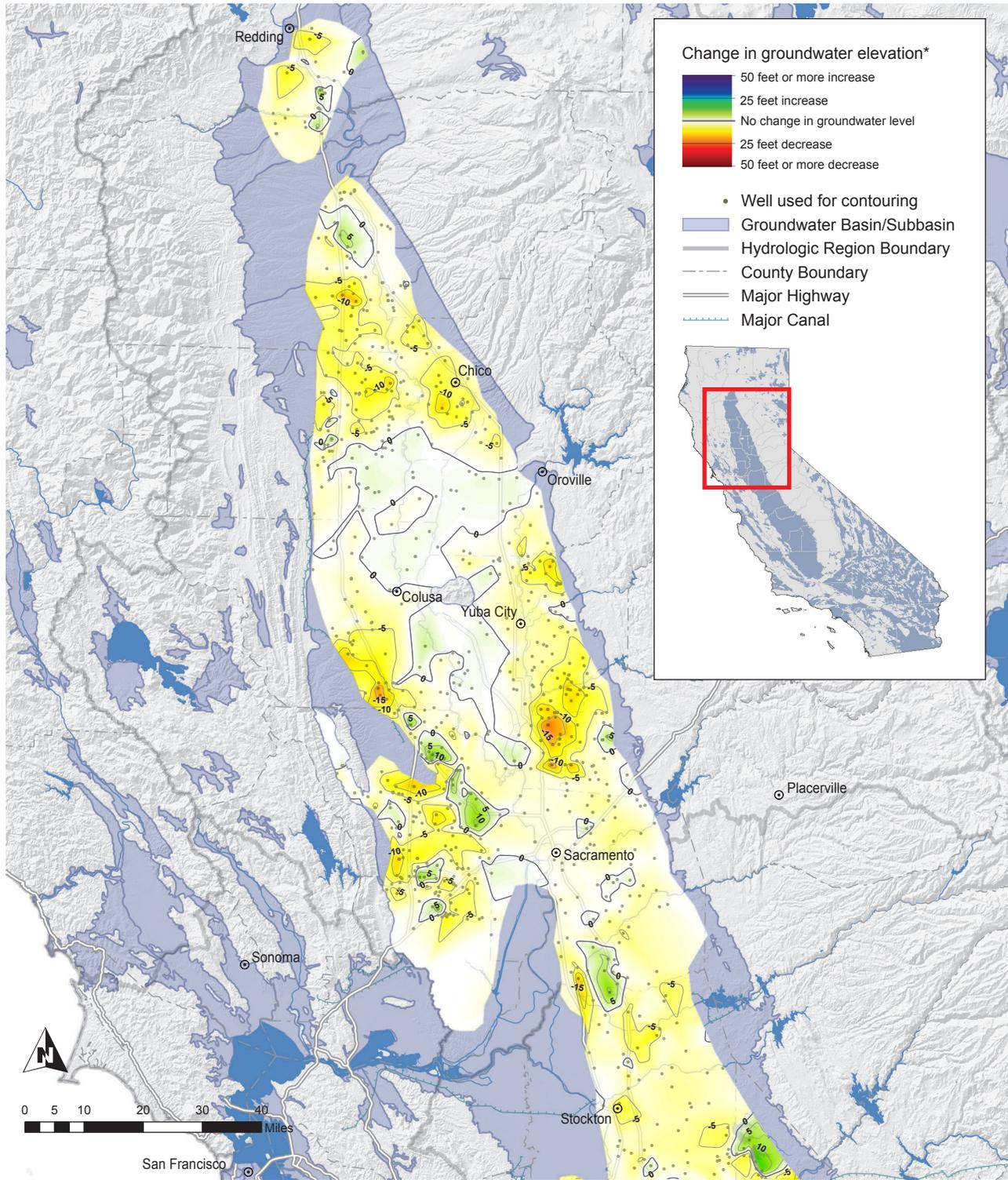
A more detailed method of evaluating groundwater conditions is through the use of groundwater level change contour maps. Groundwater level change contours represent lines of equal groundwater level change. The shape, distribution, and extent of these contours help identify the regional distribution and magnitude of local groundwater level changes. Figure 7 and Figure 8 depict regional change in groundwater levels for the northern and southern Central Valley from spring 2013 to spring 2014. For this analysis and available data set, notable decreases in groundwater levels are in basins within the San Joaquin River Hydrologic Region, and more significantly, for many basins in the Tulare Lake Hydrologic Region.

Figure 9 depicts change in groundwater levels at well locations from fall 2013 to fall 2014. Some fall 2014 data are unavailable to include in this report and may not have been uploaded to the WDL database by November 1. Based on the available data, groundwater levels have decreased in many basins throughout the state since fall 2013. Basins with notable decreases in groundwater levels are in the Sacramento River, San Joaquin River, Tulare Lake, San Francisco Bay, and South Coast hydrologic regions.

Another method for evaluating groundwater level information is to use percentile rank. Percentile rank compares individual measurements to all available measurements for a well, and is useful in determining if a specific groundwater level measurement is statistically normal, above normal, or below normal (illustrated in the legend for Figure 10). It is necessary to have adequate data to generate percentile rank. For selected wells with long periods of record, the percentile rank was calculated to discern the statistical range of groundwater levels. Wells were selected based on (1) spatial distribution within the basin; (2) those that possessed a long and complete period of record; and (3) those in High and Medium priority basins (refer to Section 5.1).

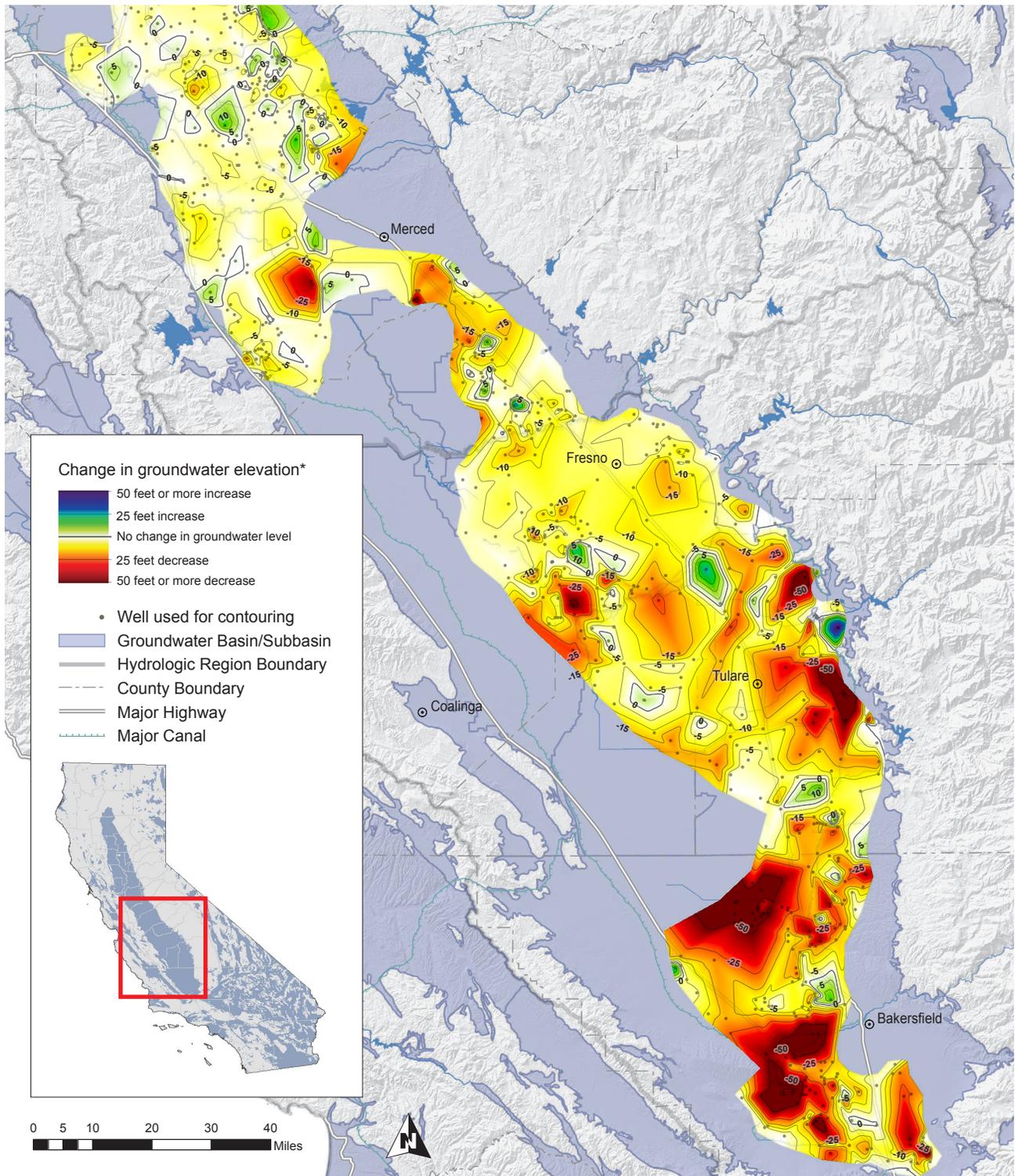
Figure 10 depicts the percentile rank of the spring 2014 groundwater level measurements for selected wells in High and Medium priority basins. Percentile rank for spring 2014 groundwater level measurements are based on the monthly median values from a given well with at least 10 years of data. The percentile rank value of the most recent measurement indicates how that measurement compares to other measurements for that well for the month studied. For example, a percentile rank of 50 matches the median water level measurement and a percentile rank of 75 indicates that the most recent measurement is higher than 75 percent of the measurements studied. Based on the available data, there are many High and Medium Priority basins that experienced spring 2014 groundwater levels which rank in the lowest 10th percentile of measurements. However, the data are not consistently available for all of the groundwater basins.

Figure 7: Change in Groundwater Elevation, Northern Central Valley - Spring 2013 to Spring 2014



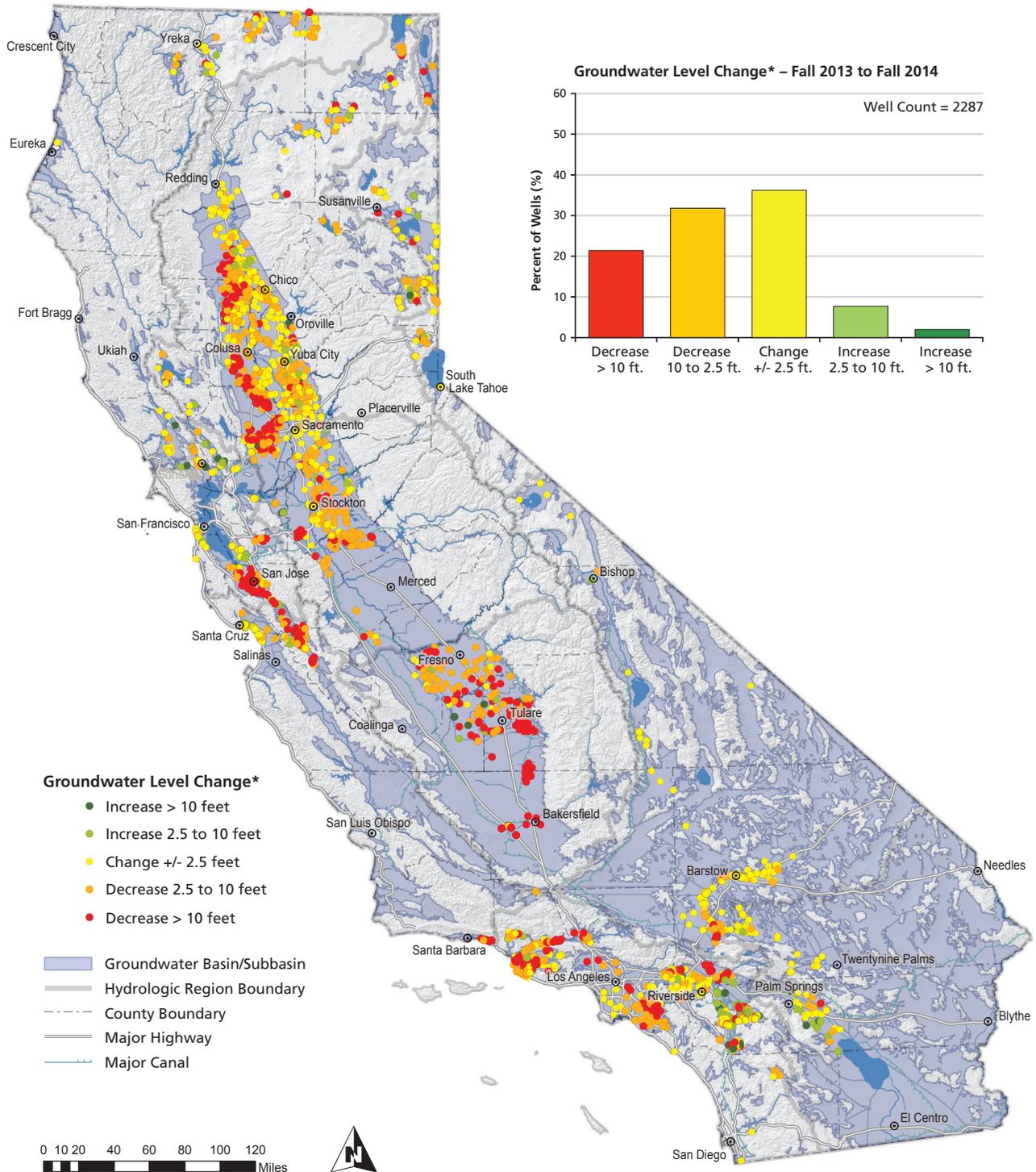
\*Groundwater level change determined from water level measurements in wells. Map based on available data from the DWR Water Data Library as of 11/08/2014. Data subject to change without notice.

Figure 8: Change in Groundwater Elevation, Southern Central Valley - Spring 2013 to Spring 2014



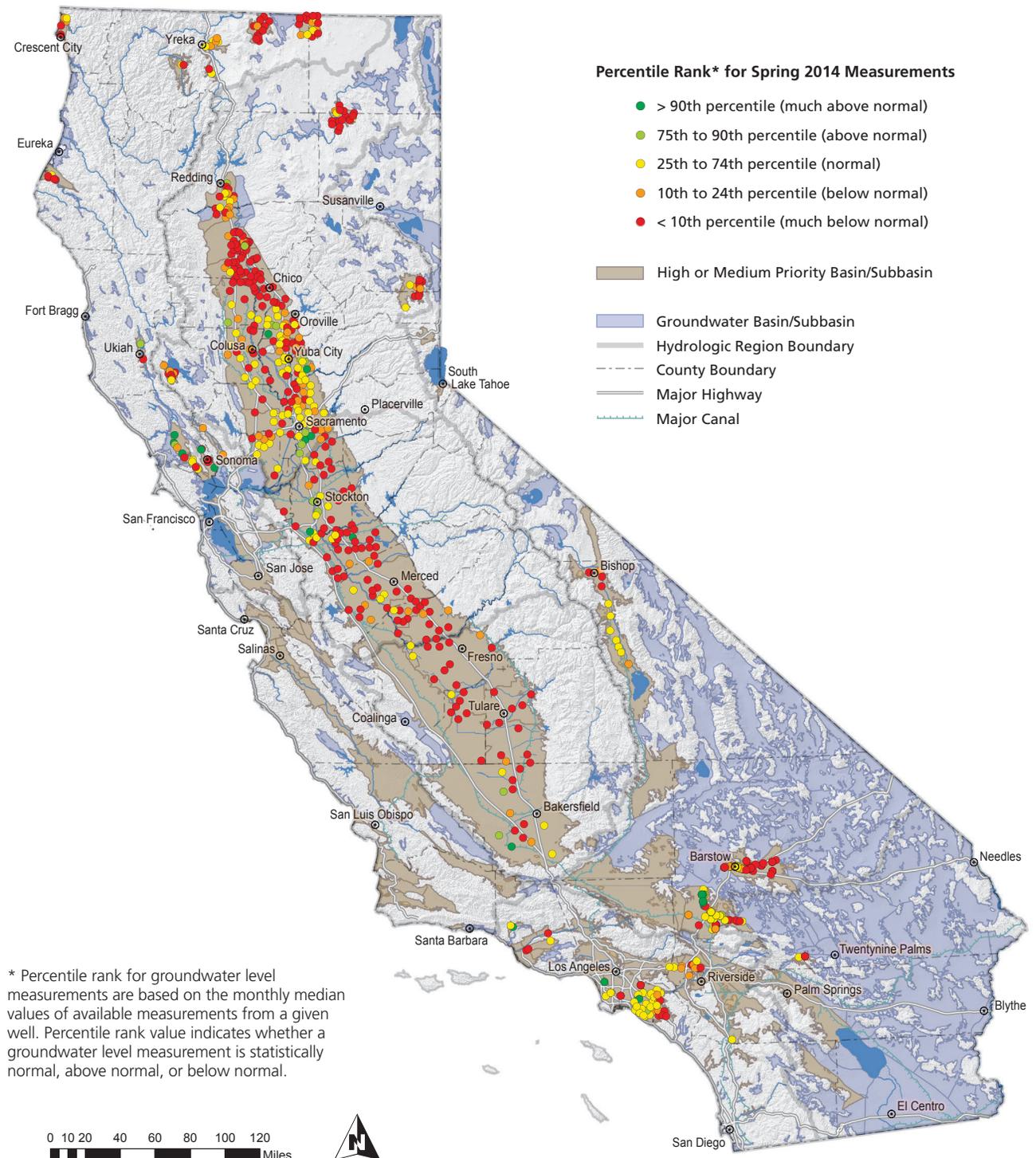
\*Groundwater level change determined from water level measurements in wells. Map based on available data from the DWR Water Data Library as of 11/08/2014. Data subject to change without notice.

Figure 9: Change in Groundwater Levels in Wells - Fall 2013 to Fall 2014



\*Groundwater level change determined from water level measurements in wells. Map and chart based on available data from the DWR Water Data Library as of 11/08/2014. Data subject to change without notice.

**Figure 10: Percentile Rank\* of Groundwater Levels in Selected Wells in High and Medium Priority Basins - Spring 2014**



Map based on available data from the DWR Water Data Library as of 11/08/2014. Data subject to change without notice.



## 5

# Gaps in Groundwater Monitoring

A groundwater monitoring gap is an informal term indicating that insufficient data exists to reasonably assess and interpret groundwater conditions in an aquifer or in a basin. There are two primary gaps that can exist in groundwater monitoring data; spatial and temporal. Spatial data gaps exist where there is inadequate horizontal and/or vertical distribution of groundwater elevation data to accurately represent or assess aquifer conditions within an area of interest. Temporal data gaps exist when a consistent record of groundwater elevation data, measured over regular time intervals, is not available. Groundwater elevation data collected at routine intervals can provide seasonal and long-term trends for a basin, which are essential for accurately estimating aquifer response and change in storage associated with changing hydrology, land use, total water supply, and effects of local groundwater management practices.

**D**WR maintains groundwater level data in the WDL groundwater level database. The WDL stores groundwater level data collected by DWR and cooperating agencies for a variety of ongoing and historical data programs. Evaluation of groundwater levels using WDL data during the 2009 drought revealed notable data gaps in groundwater level information for most basins. Implementation of the CASGEM Program facilitated updates to the WDL and the subsequent submittal and dissemination of improved groundwater elevation data, including well construction information (well depth and screen intervals), for many areas where data was previously absent and/or unavailable. Detailed information

pertaining to the CASGEM Program can be found at [www.water.ca.gov/groundwater/casgem](http://www.water.ca.gov/groundwater/casgem).

## 5.1 CASGEM BASIN PRIORITIZATION

As part of the CASGEM Program and pursuant to the California Water Code Section 10933, DWR prioritized California's groundwater basins using the following eight criteria:

1. Overlying population.
2. Projected growth of overlying population.
3. Public supply wells.
4. Total wells.
5. Overlying irrigated acreage.

6. Reliance on groundwater as the primary source of water.
7. Impacts on the groundwater; including overdraft, land subsidence, saline intrusion, and other water quality degradation.
8. Any other information determined to be relevant by DWR.

CASGEM groundwater basin prioritization (Basin Prioritization) is a statewide ranking of groundwater basin importance. Although the results are a statewide assessment, it is important to recognize the statewide findings are not intended to diminish the local importance of groundwater to the smaller size or lower-use groundwater basins.

DWR released the final Basin Prioritization results in June 2014. According to the June 2014 results, 127 of California's 515 groundwater basins and subbasins are categorized as High or Medium priority (Figure 11). These 127 basins account for 96 percent of California's annual groundwater use and 88 percent of the population overlying the groundwater basins. The remaining 388 groundwater basins are categorized as Low or Very Low priority. The Basin Prioritization process and results may change in the future. Details of the most recent Basin Prioritization process, results, and an interactive map, are at [water.ca.gov/groundwater/casgem/](http://water.ca.gov/groundwater/casgem/).

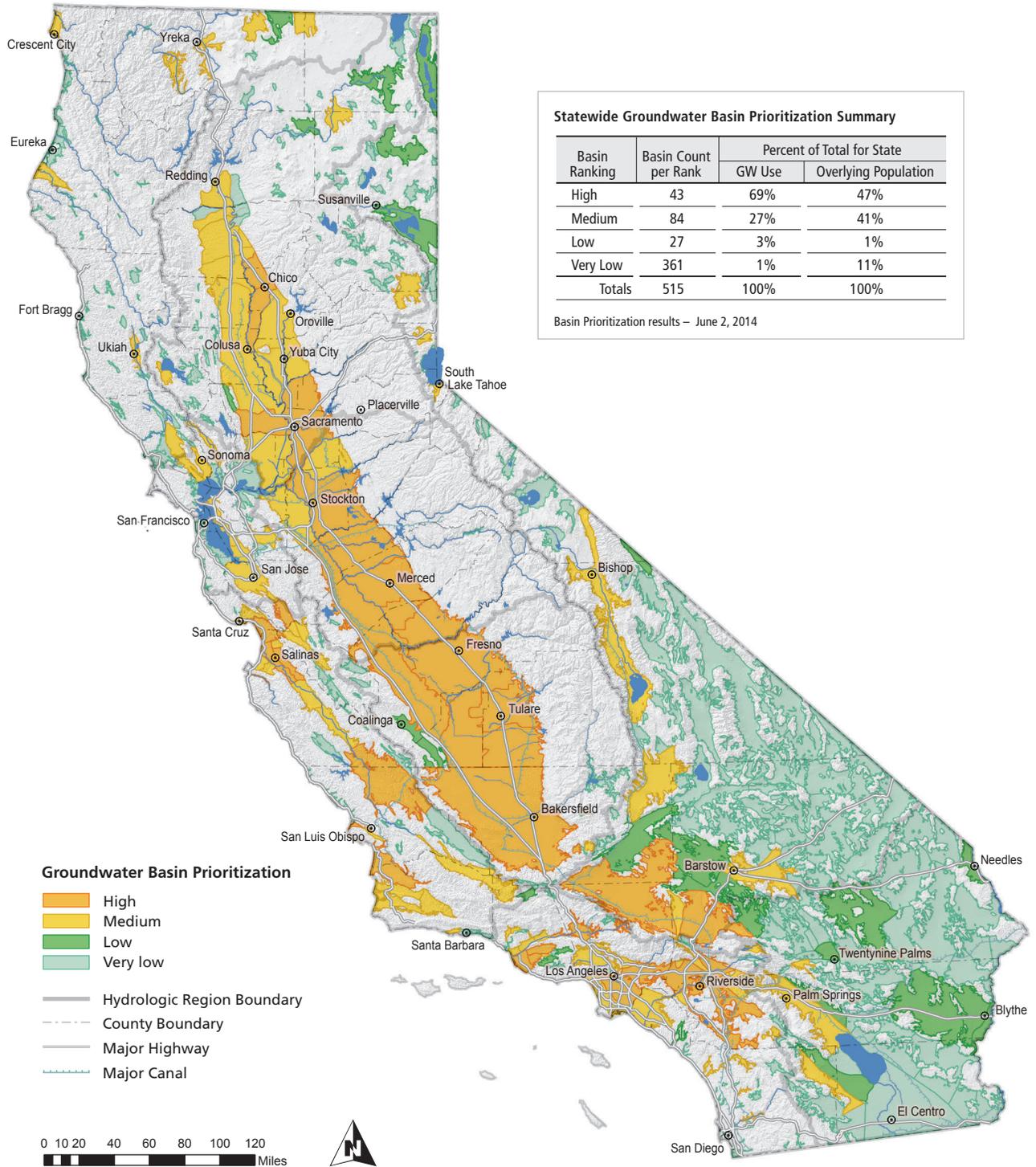
## 5.2 CASGEM GROUNDWATER LEVEL MONITORING

As of October 7, 2014, 93 of the 127 High and Medium priority groundwater basins are fully monitored by a designated Monitoring Entity under the CASGEM Program. A Monitoring Entity is a local agency or group that voluntarily takes responsibility for coordinating groundwater level monitoring and data reporting for all or part of a groundwater basin. For the balance of High and Medium priority basins, 17 are partially monitored and 17 are fully unmonitored by a designated Monitoring Entity. The unmonitored High and Medium priority basins (or portions thereof) as of October 7, 2014, are considered gaps in groundwater monitoring. Figure 12 identifies the CASGEM monitoring status for High and Medium priority basins. For the High and Medium priority basins, there are significant gaps in groundwater monitoring for the San Joaquin River, Tulare Lake, and Central Coast hydrologic regions. Table 1 includes a complete list of the High and Medium priority basins and subbasins that are either partially or fully unmonitored as of October 7, 2014.

## 5.3 STATEWIDE GROUNDWATER LEVEL MONITORING

On a statewide scale, wells available for groundwater level monitoring, and with associated groundwater levels in the WDL database, are identified as either CASGEM or Voluntary wells. These wells can vary and may include dedicated monitoring wells or wells used for irrigation, domestic, public supply, industrial, or other purposes. As of October 1, 2014, there are about 4,700 CASGEM wells and 40,000 Voluntary wells represented in the WDL groundwater level database. Figure 13 shows the statewide distribution of groundwater level monitoring data collected in spring 2014.

Figure 11: CASGEM Basin Prioritization - June 2014

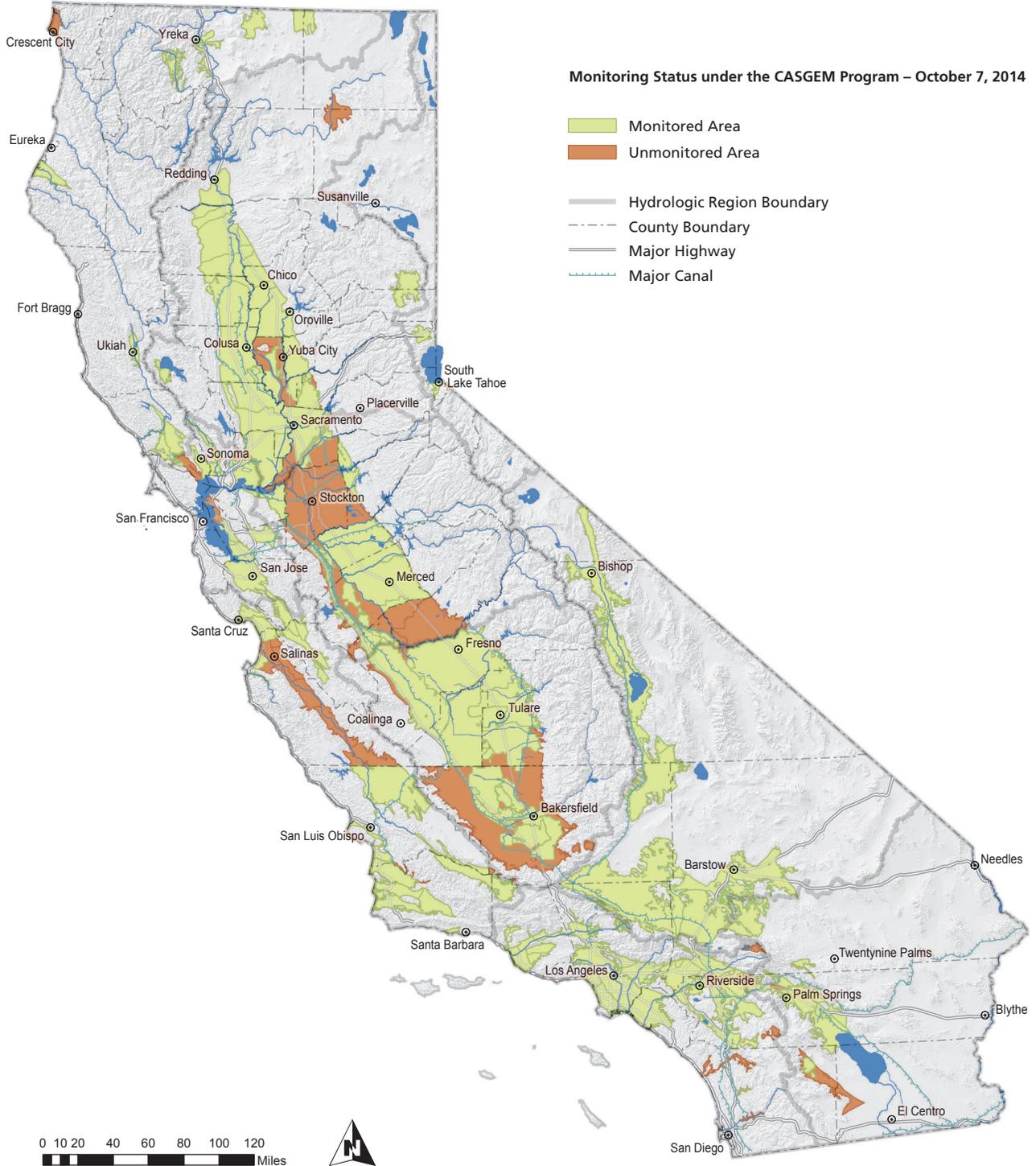


Statewide Groundwater Basin Prioritization Summary

Basin Ranking	Basin Count per Rank	Percent of Total for State	
		GW Use	Overlying Population
High	43	69%	47%
Medium	84	27%	41%
Low	27	3%	1%
Very Low	361	1%	11%
Totals	515	100%	100%

Basin Prioritization results – June 2, 2014

Figure 12: CASGEM Monitoring Status for High and Medium Priority Basins - October 7, 2014

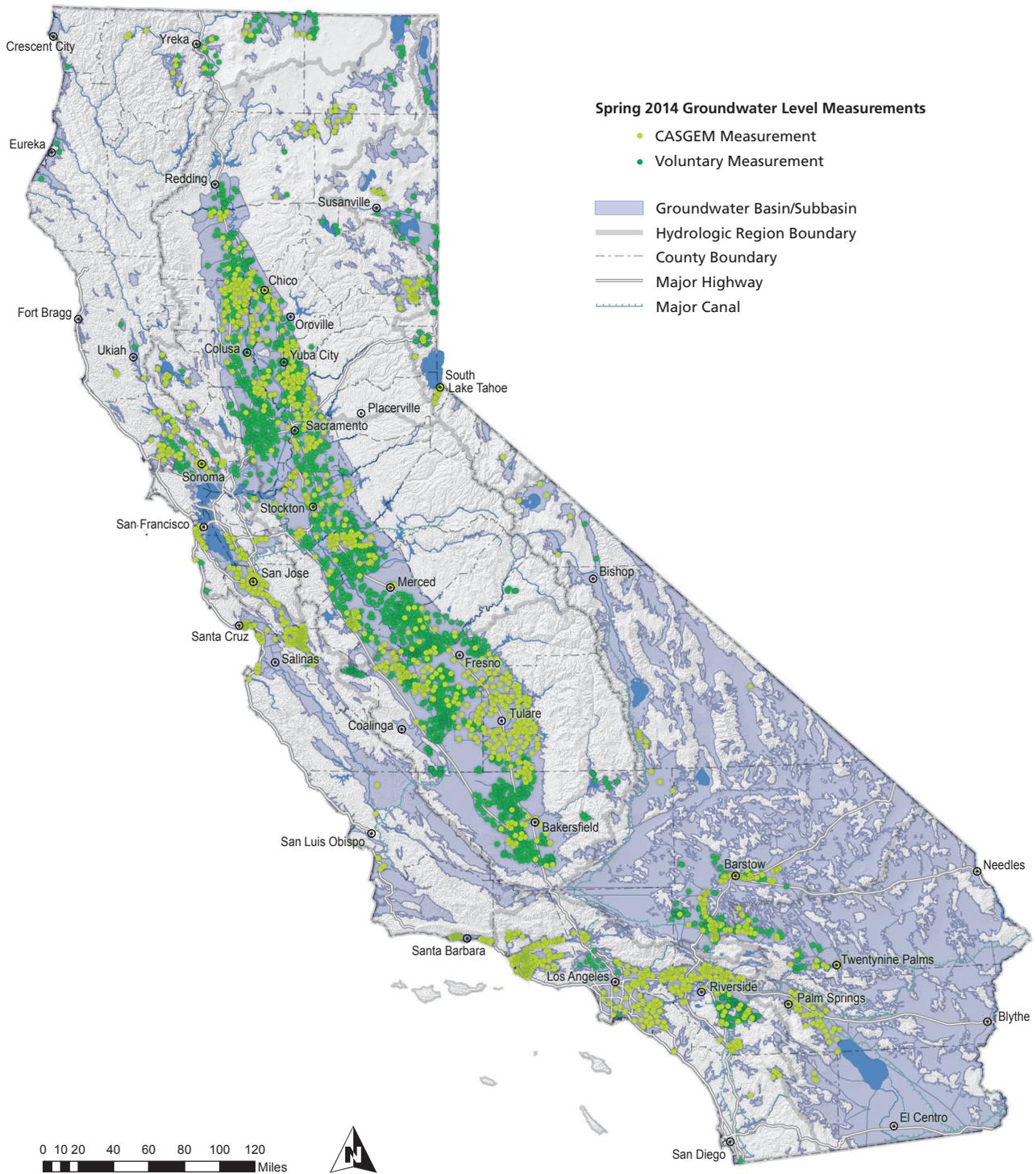


**Table 1: Unmonitored High and Medium Priority Basins - October 7, 2014**

Basin Number	Basin Name	Subbasin Name	Priority	Unmonitored Status (as of 10/07/2014)
1-1	SMITH RIVER PLAIN		Medium	Fully
2-1	PETALUMA VALLEY		Medium	Fully
2-9.04	SANTA CLARA VALLEY	EAST BAY PLAIN	Medium	Partially
3-13	CUYAMA VALLEY		Medium	Partially
3-4.01	SALINAS VALLEY	180/400 FOOT AQUIFER	High	Fully
3-4.02	SALINAS VALLEY	EAST SIDE AQUIFER	High	Fully
3-4.04	SALINAS VALLEY	FOREBAY AQUIFER	Medium	Fully
3-4.05	SALINAS VALLEY	UPPER VALLEY AQUIFER	Medium	Fully
3-4.06	SALINAS VALLEY	PASO ROBLES AREA	High	Partially
3-4.09	SALINAS VALLEY	LANGLEY AREA	Medium	Fully
3-4.10	SALINAS VALLEY	CORRAL DE TIERRA AREA	Medium	Fully
5-21.59	SACRAMENTO VALLEY	EAST BUTTE	Medium	Partially
5-21.62	SACRAMENTO VALLEY	SUTTER	Medium	Partially
5-21.64	SACRAMENTO VALLEY	NORTH AMERICAN	High	Partially
5-21.65	SACRAMENTO VALLEY	SOUTH AMERICAN	High	Partially
5-21.66	SACRAMENTO VALLEY	SOLANO	Medium	Partially
5-22.01	SAN JOAQUIN VALLEY	EASTERN SAN JOAQUIN	High	Partially
5-22.05	SAN JOAQUIN VALLEY	CHOWCHILLA	High	Partially
5-22.06	SAN JOAQUIN VALLEY	MADERA	High	Fully
5-22.07	SAN JOAQUIN VALLEY	DELTA-MENDOTA	High	Partially
5-22.13	SAN JOAQUIN VALLEY	TULE	High	Partially
5-22.14	SAN JOAQUIN VALLEY	KERN COUNTY	High	Partially
5-22.15	SAN JOAQUIN VALLEY	TRACY	Medium	Partially
5-22.16	SAN JOAQUIN VALLEY	COSUMNES	Medium	Partially
5-27	CUMMINGS VALLEY		High	Fully
5-28	TEHACHAPI VALLEY WEST		Medium	Fully
5-4	BIG VALLEY		Medium	Fully
7-21.01	COACHELLA VALLEY	INDIO	Medium	Partially
7-24	BORREGO VALLEY		Medium	Partially
8-9	BEAR VALLEY		Medium	Fully
9-15	SAN DIEGO RIVER VALLEY		Medium	Fully
9-4	SANTA MARGARITA VALLEY		Medium	Fully
9-6	CAHUILLA VALLEY		Medium	Fully
9-7	SAN LUIS REY VALLEY		Medium	Fully

*Note: Fully unmonitored is a basin/subbasin that does not have a designated CASGEM Monitoring Entity. Partially unmonitored is a basin/subbasin where a portion of the basin/subbasin does not have a designated CASGEM Monitoring Entity.*

Figure 13: Statewide Distribution of Groundwater Level Monitoring - Spring 2014



#### 5.4 CASGEM EXTENT OF MONITORING

As of October 7, 2014, 222 of the 515 alluvial groundwater basins have at least one designated Monitoring Entity under the CASGEM Program. Although significant progress was achieved through implementation of the CASGEM Program since 2010, additional work is needed to establish adequate monitoring of the groundwater basins on a statewide scale. There can be data gaps at different scales; unmonitored basins are data gaps themselves, yet there can also be monitored basins that have data gaps in their existing monitoring networks. The California Water Code requires DWR to determine the extent of CASGEM monitoring and to report its findings to the governor and Legislature. In August 2014, DWR began evaluating the extent and adequacy of groundwater elevation monitoring efforts and documented data gaps. Specific data gaps identified in the review include:

- » Horizontal data gaps within the defined monitoring area.
- » Insufficient density of monitoring networks with respect to the areal extent of a basin.
- » Well construction data gaps (total depth and screened interval).
- » Temporal data gaps:
  - CASGEM wells not monitored on a frequency of at least twice a year.
  - Monitoring is occurring twice a year, but not all of the CASGEM wells identified in the monitoring plan are monitored and/or reported.
- » Insufficient documentation and discussion of monitoring network data gaps.

Based on the initial screening of available CASGEM data, DWR compiled the results for each designated basin and subbasin. DWR contacted each Monitoring Entity to discuss the results of the data compilation/evaluation and any data gaps identified in their monitoring networks.

DWR requested all of the Monitoring Entities review the information, report any errors, and provide any correct data/information by September 15, 2014.

Results of the extent of monitoring analysis reveal that data gaps still exist in many groundwater basins. For spatial and temporal data gaps, the evaluation revealed the following key elements:

- » Difficulties acquiring suitable wells for CASGEM monitoring networks.
- » Reluctance of private well owners to grant permission to Monitoring Entities to monitor their wells and/or release the well construction details to the public.
- » Reliance on production wells with unsuitable construction.
- » Lack of well construction information (total depth and screened intervals) for existing wells.
- » Lack of financial resources to install dedicated monitoring wells.
- » Monitoring Entities not uploading their groundwater level monitoring data.
- » Long lag times between collection of groundwater level monitoring data and data upload to the WDL database.

DWR plans to include the results of this evaluation in the January 2015 CASGEM Program status report to the governor and Legislature.



## 6

# Land Subsidence

Inelastic land subsidence (subsidence) caused by groundwater extraction and compaction of fine-grained materials in aquifers is a significant problem in many parts of California and can be exacerbated by additional strain on groundwater resources during periods of drought. Subsidence has occurred historically and continues in many areas of California. Subsidence creates problems for water conveyance and delivery infrastructure by altering flow gradients in waterways. The extent of damage is often unrealized until long after the fact and water and infrastructure managers would benefit from the use of timely satellite (remote sensing) observations of changes in land surface elevation to augment existing on-the-ground measurements to improve early detection of subsidence.

## 6.1 SUMMARY OF RECENT, HISTORICAL, AND ESTIMATED POTENTIAL FOR FUTURE LAND SUBSIDENCE

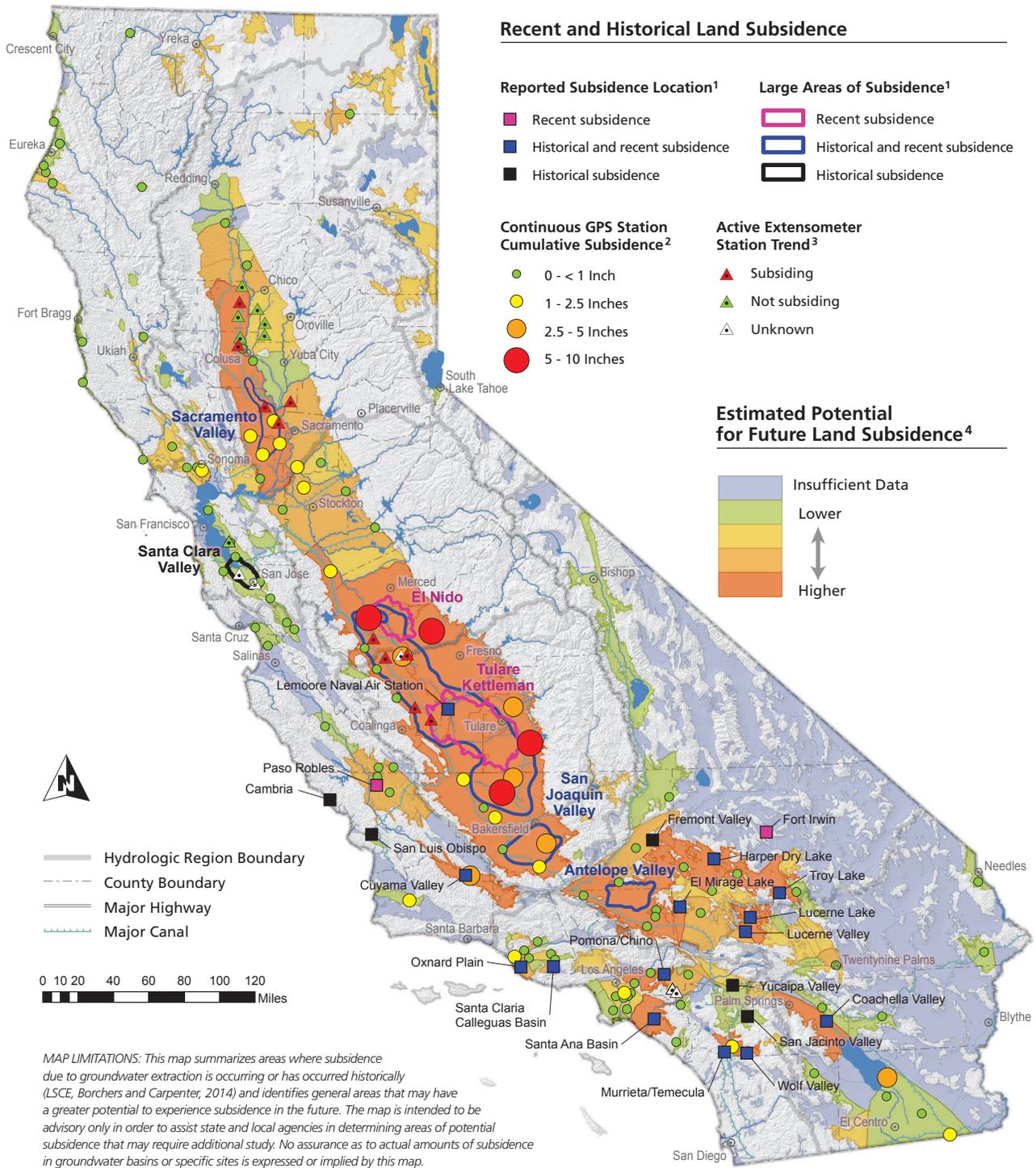
DWR conducted a study to summarize recent and historical subsidence, and estimate the potential for future subsidence within California's 515 groundwater basins and subbasins. The results of the study can be used as a screening tool to identify areas where the potential for subsidence exists due to persistent declining water levels, and to guide future site-specific subsidence studies. This information has been compiled into a final report and interactive map available at [www.water.ca.gov/groundwater/](http://www.water.ca.gov/groundwater/).

The subsidence study included an assessment of groundwater levels, review of previous subsidence studies, and compilation of borehole extensometer and continuous global positioning system (GPS) station

information. Figure 14 presents a summary of the pertinent data and identifies basins and their potential for future land subsidence as of May 2014. The key findings of the study are:

1. Subsidence is occurring in many groundwater basins in the state, especially in the southern San Joaquin River and Tulare Lake hydrologic regions.
2. Areas with a higher potential for future subsidence are in the southern San Joaquin, Antelope, Coachella, and western Sacramento valleys.
3. Most groundwater basins with a higher potential for future subsidence are also identified as High or Medium priority basins (CASGEM Basin Prioritization).
4. Since spring 2008, groundwater levels are at

Figure 14: Summary of Recent, Historical, and Estimated Potential for Land Subsidence



<sup>1</sup> Land subsidence data modified from LSCE, Borchers and Carpenter, 2014. <sup>2</sup> Continuous GPS data from UNAVCO.org.

<sup>3</sup> Extensometer data from DWR (<http://www.water.ca.gov/waterdata/library>) and LSCE, Borchers and Carpenter, 2014

<sup>4</sup> For more information on how the estimated potential for land subsidence was calculated see:

[http://www.water.ca.gov/groundwater/docs/Summary\\_of\\_Recent\\_Historical\\_Potential\\_Subsidence\\_in\\_CA\\_Final\\_with\\_Appendix.pdf](http://www.water.ca.gov/groundwater/docs/Summary_of_Recent_Historical_Potential_Subsidence_in_CA_Final_with_Appendix.pdf)

Data current as of May 2014.

all-time lows (for the period of record) in many areas of the state. The southern San Joaquin Valley, portions of the Sacramento Valley, and portions of the San Francisco Bay, South Lahontan, and South Coast hydrologic regions exhibit recent groundwater levels more than 50 feet below previous lows experienced prior to 2000. There are many areas of the San Joaquin Valley where recent groundwater levels are more than 100 feet below previous lows and also correspond to known areas of recent subsidence.

5. Groundwater levels in about 35 percent of the long-term monitoring wells in the Sacramento Valley, and in about 55 percent of the long-term monitoring wells in the San Joaquin Valley, are at or below historical spring low levels.

Future studies should incorporate the results of a satellite-based land subsidence study of the Central Valley (see Section 6.2), integrate site-specific lithologic data, and include updated groundwater level, extensometer, and continuous GPS station data. The inclusion of this additional data could further support the identification of areas of new and continuing subsidence.

## **6.2 INTERFEROMETRIC SYNTHETIC APERTURE RADAR DATA EVALUATION**

In summer 2014, DWR contracted with the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory for the use of satellite-based Interferometric Synthetic Aperture Radar (InSAR) data to measure relative changes in land surface elevation (ground deformation) in the Sacramento and San Joaquin valleys from 2007 through 2014 where satellite imagery was available. This analysis is expected to be completed by summer 2015. There are significant limitations, both spatial and temporal, in availability of historical InSAR imagery; only parts of the Sacramento Valley and San Joaquin Valley are covered, and data must be pieced together from multiple satellite plat-

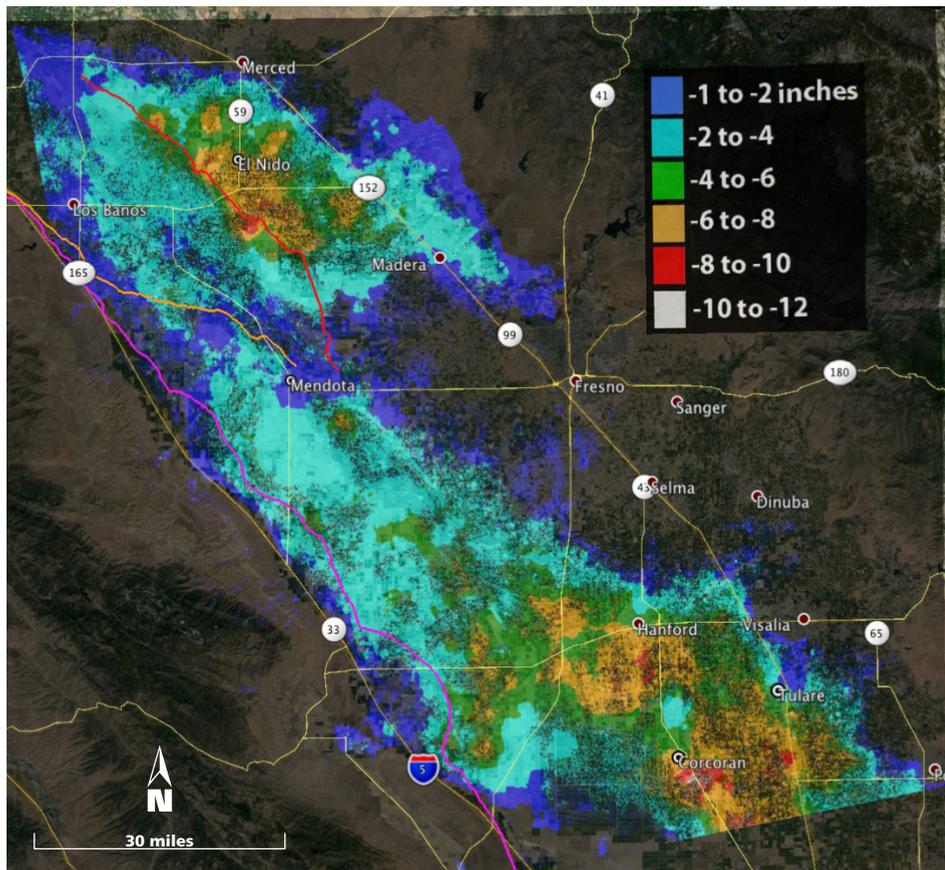
forms. The data do not exist to provide comprehensive historical coverage of the Central Valley. The purpose of this analysis is to use the available imagery to identify active subsidence areas that should be followed up with ground-based surveys. Additionally, a test area along the California Aqueduct will also be evaluated using aircraft-based InSAR data. The purpose of collecting and analyzing the aircraft-based data is to compare measurement precision with that of satellite-based data. Figure 15 is a preliminary image of relative land surface displacement in part of the San Joaquin Valley from May 5 to October 2014. The figure illustrates the spatial scale of the satellite imagery evaluated as part of the ongoing study.

**Figure 15: Preliminary Image of Relative Land Surface Displacement, San Joaquin Valley - May to October 2014.**

**Subsidence, May 3 - October 18, 2014**  
 Measured by Radarsat-2, processed by  
 Jet Propulsion Laboratory

**Legend**

- California Aqueduct
- Delta-Mendota Canal
- Eastside Bypass



# Agricultural Land Fallowing

Under a five-year federally funded research grant, NASA, the U.S. Geological Survey, and the U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS) are developing a system for DWR that will estimate Central Valley idled (fallowed) agricultural acreage during the growing season. 2014 is the third year of project work, and the first year of using satellite imagery processing algorithms developed by NASA. The project uses measures of vegetation greenness obtained via sensors on NASA's Landsat 7, Landsat 8, Terra, and Aqua satellites, and covers about 200,000 fields every 8 days. The project's purpose is to provide rapid (monthly) estimates of non-cropped Central Valley acreage during the growing season for use in monitoring impacts of agricultural water shortages. Data are provided in a GIS format that allows summary tabulation by jurisdictional boundaries, such as counties. The satellite imagery quantifies all idled lands. The reasons fields may be fallow include water shortage due to drought, normal agronomic crop rotation practices, or market conditions. The effects of drought can be assessed by comparing idled acreage in a dry year, such as 2014, against a recent wet year, such as 2011.

Use of satellite imagery to estimate vegetative status requires that the plant canopy is large enough to be observed by the sensors. Newly emergent annual crops and recently planted orchard seedlings may lack sufficient greenness to be measurable. All remote sensing methods require ground-truthing to ensure that processed imagery correctly reflects actual field conditions. This project used transects of approximately 10,000 fields to validate the data processing algorithms, as well as cross-checking against USDA-NASS survey information. Monthly accuracy for 2014, based on the

ground-truthing, was within approximately 16 percent.

Table 2 shows a summary of idled acreage as of July 2014, taken as the approximate time when the maximum agricultural acreage would be planted. Results for 2014 are compared to the last wet year of 2011. As indicated in the table, summer idled land refers to land not planted since June 1. The analysis demonstrates the impacts of dry conditions by comparing results from 2011 and 2014. For 2011, just more than one million acres were idle during the peak summer growing period. In contrast, 2014 early-season idled acreage was high

due to lack of precipitation and to growers saving available irrigation supplies for summer crops and permanent plantings. Late planting of annual crops caused by water supply uncertainty also contributed to high early season idled acreage, as newly emergent vegetation was too small to be detected by satellite. Estimated peak summer land idling in 2014 was 1.7 million acres, almost 700,000 acres more than in 2011. Figure 16 and Figure 17 show the spatial distribution of idled acreage for 2011 and 2014, respectively.

Other entities also make estimates of land fallowing. USDA NASS will publish its retrospective analysis of 2014 agricultural acreage, which includes fallowed land, in 2015 as part of its nationwide cropland data layer (<http://www.nass.usda.gov/research/Cropland/SARS1a.htm>). The NASS data are based on direct measurement by remote sensing combined with ground-truthing, and, similar to the research being performed for DWR, will identify all acreage fallowed for any reason. An indirect estimate of Central Valley land fallowing was made in a July 2014 University of California, Davis (UCD) study that used an economic modeling approach to estimate drought socioeconomic impacts. The UCD study concluded that approximately 409,000 acres of land were fallowed specifically due to drought ([https://watershed.ucdavis.edu/files/biblio/DroughtReport\\_23July2014\\_0.pdf](https://watershed.ucdavis.edu/files/biblio/DroughtReport_23July2014_0.pdf)).

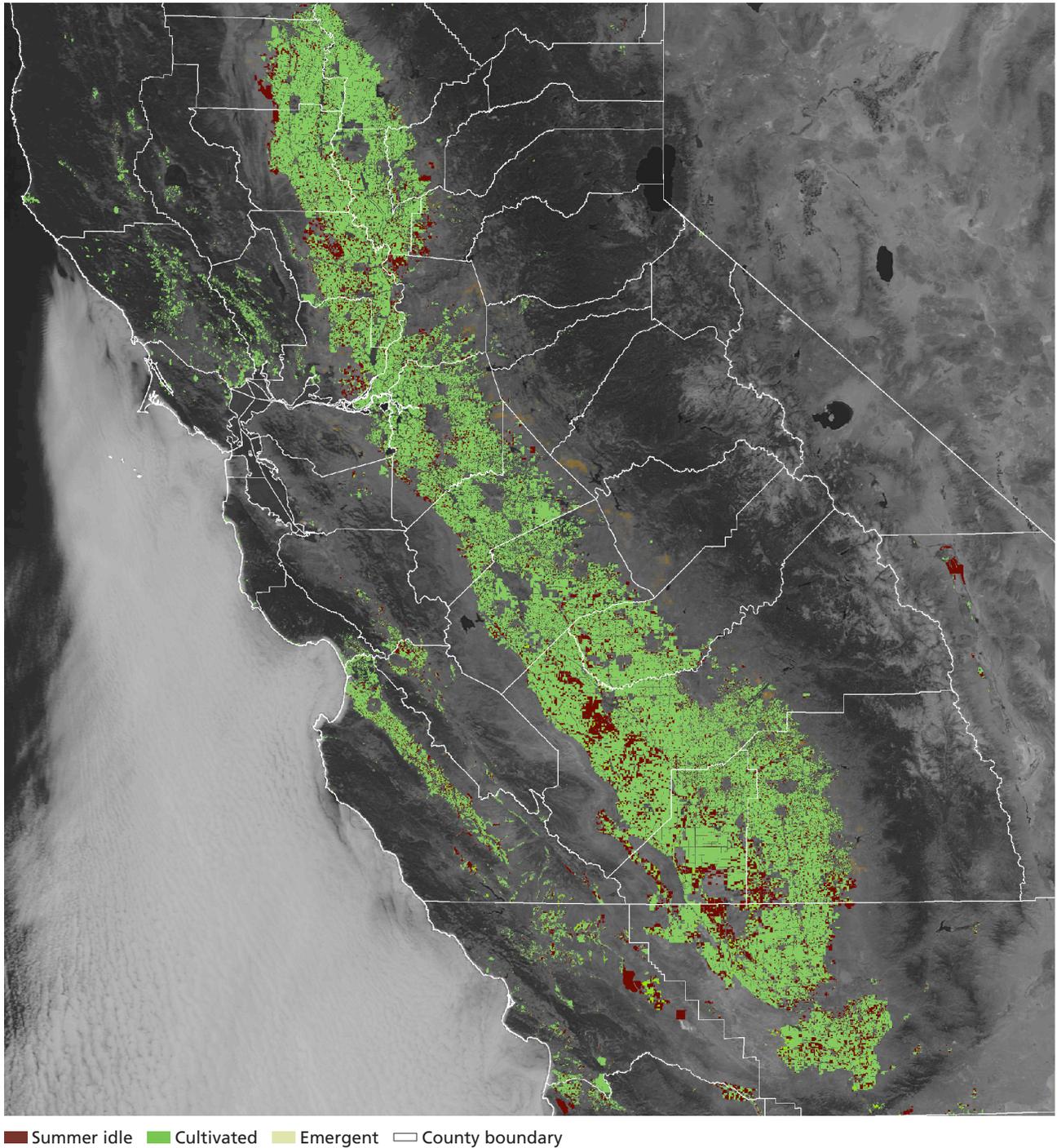
**Table 2: Central Valley Total Idled Acreage July 27, 2014**

Year	Summer Idled (Acres)
2014	1,706,038
2011	1,013,233
2014 - 2011	692,805

**Notes:**

- Summer Idle: No crop detected since June 1
- Data source: NASA Ames Research Center / CSU Monterey Bay
- Accuracy for the estimates from NASA is +/- 16%, based on comparisons with monthly field observations collected across the Central Valley from April-July, 2014.

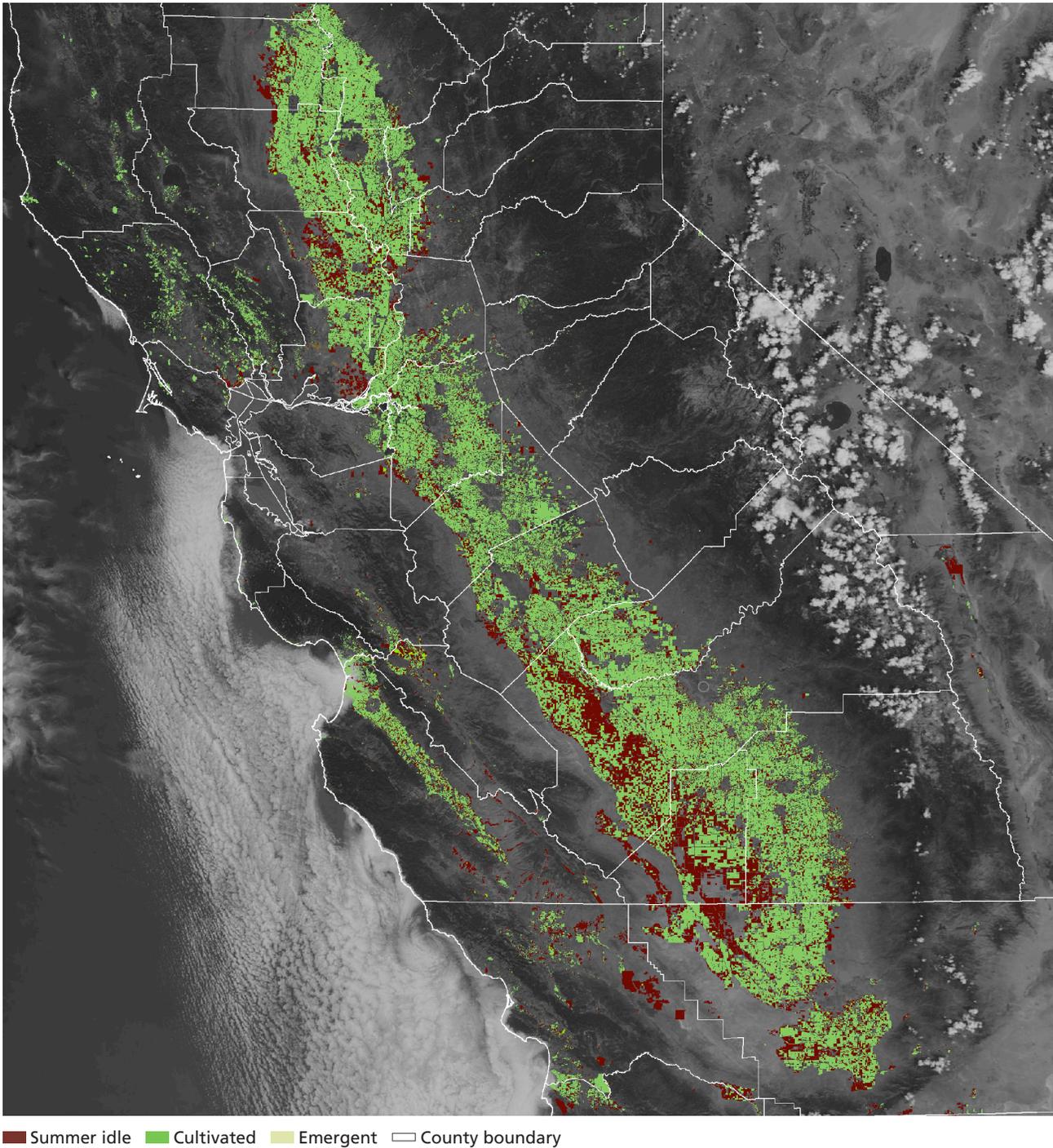
Figure 16: Spatial Distribution of Idled Acreage - July 27, 2011



July 27, 2011 Central Valley Summer Conditions (June 1 – July 27)

Data source: NASA / CSU Monterey Bay. Map derived from data from Landsat 7, Landsat 8, Terra and Aqua satellites. Satellite observations for ~200,000 fields obtained every 8 days.

Figure 17: Spatial Distribution of Idled Acreage - July 27, 2014



July 27, 2014 Central Valley Summer Conditions (June 1 – July 27)

Data source: NASA / CSU Monterey Bay. Map derived from data from Landsat 7, Landsat 8, Terra and Aqua satellites. Satellite observations for ~200,000 fields obtained every 8 days.

## 8

# Small Water Systems and Private Residential Wells

There are about 7,500 water systems of varying sizes in California that provide drinking water to about 98 percent of the state's population. The State Water Resources Control Board (SWRCB) Division of Drinking Water has responsibility to regulate the public water systems which have at least 15 service connections, or serve at least 25 people at least 60 days per year. This includes those serving large metropolitan areas and those serving small communities, places of business, parks and similar facilities which have their own independent water supply (the vast majority have at least one well).

The majority of the larger regulated water systems have adequate resources to develop and implement water shortage contingency plans during a drought. Individual private wells and water systems that serve fewer than 15 homes and fewer than 25 people are not regulated by the SWRCB. Some of the smaller non-public water systems are regulated by the individual county. Most counties do not have the resources to monitor, regulate and respond to emergencies for these small water systems and residential wells.

Regardless of water year type, small systems and private residential wells are most likely to experience water shortage problems, and health and safety impacts, that require some type of technical and/or financial assistance. Although small systems serve a small percentage of California's total population, they constitute the majority of the state's public water

systems. Small systems tend to be located outside the state's major metropolitan areas, often in lightly populated rural areas where opportunities for interconnections with another system or water transfers are limited or don't exist. Most small system drought problems stem from dependence on an unreliable water source, commonly groundwater in fractured rock systems or in small coastal terrace groundwater basins. Small systems also have limited financial resources and rate bases that constrain their ability to undertake major capital improvements or to fund adequate emergency responses. Droughts do highlight many of the existing vulnerabilities of California's water supply systems. Historically, particularly at-risk geographic areas in the state have been the foothills of the Sierra Nevada and Coast Range, inland Southern California, and the North and Central Coast regions.

The State has been challenged to obtain complete information about water supply/private well problems throughout the state during this current drought. As of November 20, 2014, 1,483 incidents of domestic water issues from 36 counties have been reported to the State, with more than half of these reports generated in Tulare County. Other counties facing and reporting significant ongoing issues are Madera, Butte, Fresno, Inyo, and Tehama. However, this count does not capture all of the water supply and well issues currently existing throughout the state.

Led by the Governor's Office of Planning and Research, a working group from the Governor's Drought Task Force has been meeting since May 2014 to identify drought impacts and solutions for portions of California that have been impacted by drought. The working group created a Domestic Water Issues Intake Form (<http://bit.ly/CADomesticWaterIssues>) for State and local agencies to document information regarding households and/or small community systems that are experiencing water shortages, including dry wells. Data from the participating agencies is electronically submit-

ted and maintained in a California Office of Emergency Services database.

A primary use of the data collected by the form is to populate a GIS-based water supply vulnerability map that the working group has been developing. The goal of the vulnerability map will be to help identify potential locations of future water supply and well issues. The map will use information including water supply problem data, water system boundaries and groundwater basin and level information to predict the location of possible water supply problems. This will allow State and local agencies to establish a suite of plausible solutions in current drought conditions and in advance of future water supply issues.

The State recognizes the vulnerability of small water systems and private residential wells during critically dry and drought conditions. Improving data collection, developing prediction tools, and insuring local water contingency plans are in place will help reduce the impacts that future droughts may have on small water systems and private wells.

## 9

# Conclusion

California's Water Year 2014 was one of the driest in decades and followed two consecutive dry years throughout the state. Continued drought conditions have resulted in the increased use of groundwater to meet demand. Increased use of groundwater is characterized by the relative amount of new water supply wells constructed this drought year and the continued decline of water levels in many basins. Although the collection and evaluation of both seasonal and long-term groundwater level data are critical to assess the conditions of an alluvial groundwater basin, significant data monitoring gaps exist in the San Joaquin River, Tulare Lake, and Central Coast hydrologic regions. In some areas, continued groundwater pumping may cause land subsidence and resultant potential impacts to

water conveyance, flood control, and other ground-based infrastructure. Drought conditions can also cause significant economic impacts to major water-dependent industries such as agriculture. A multi-agency research project led by NASA estimated that peak summer acreage of Central Valley land idled (due to drought impacts, normal agronomic practices, crop markets, etc.) in 2014 was 1.7 million acres.

Information regarding current drought conditions and DWR's drought response efforts is available at [www.water.ca.gov/waterconditions](http://www.water.ca.gov/waterconditions). For the latest groundwater level data and detailed information regarding groundwater and groundwater management in California, please visit DWR's Groundwater Information Center at [www.water.ca.gov/groundwater](http://www.water.ca.gov/groundwater).







California Department of Water Resources

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[www.water.ca.gov/waterconditions/](http://www.water.ca.gov/waterconditions/)

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